

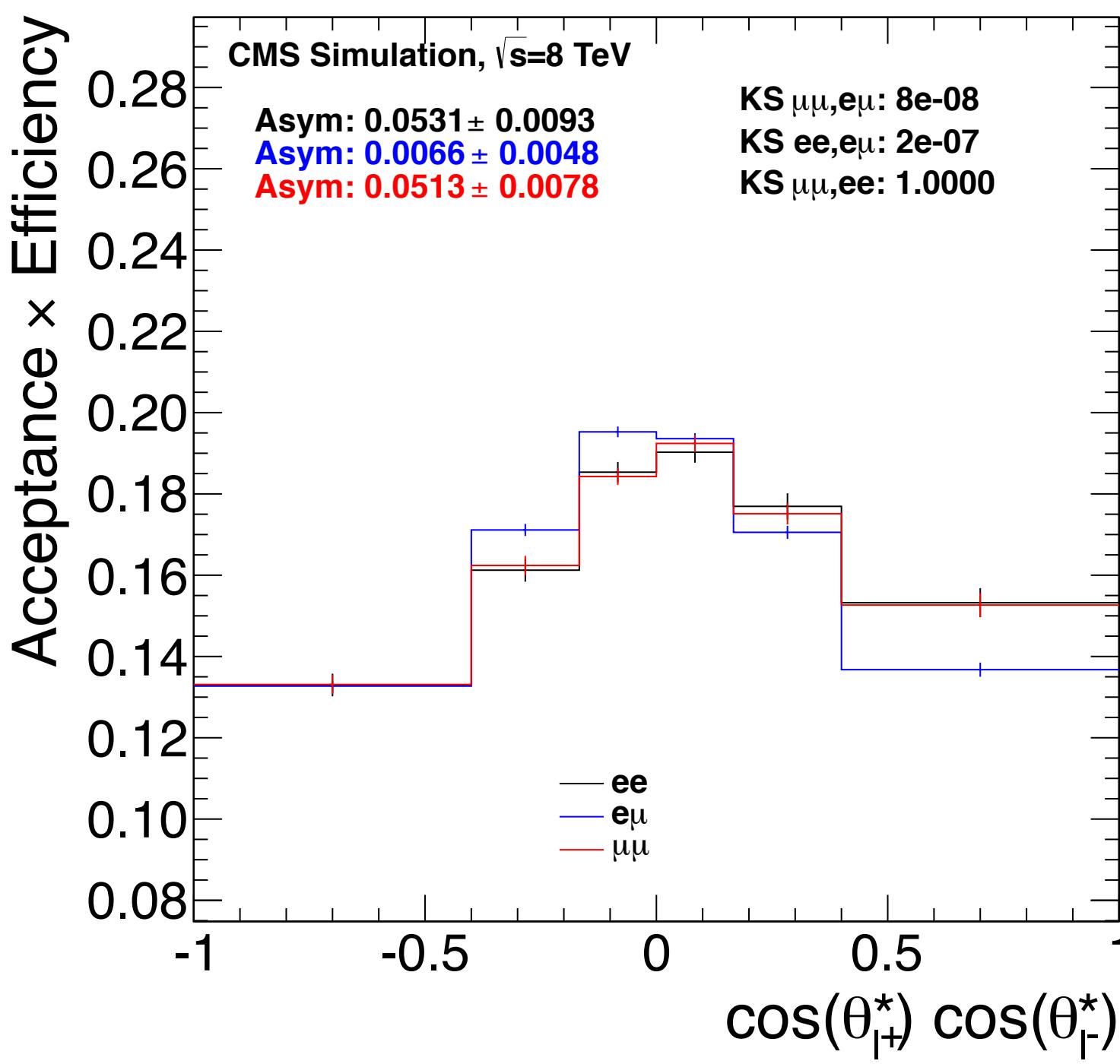
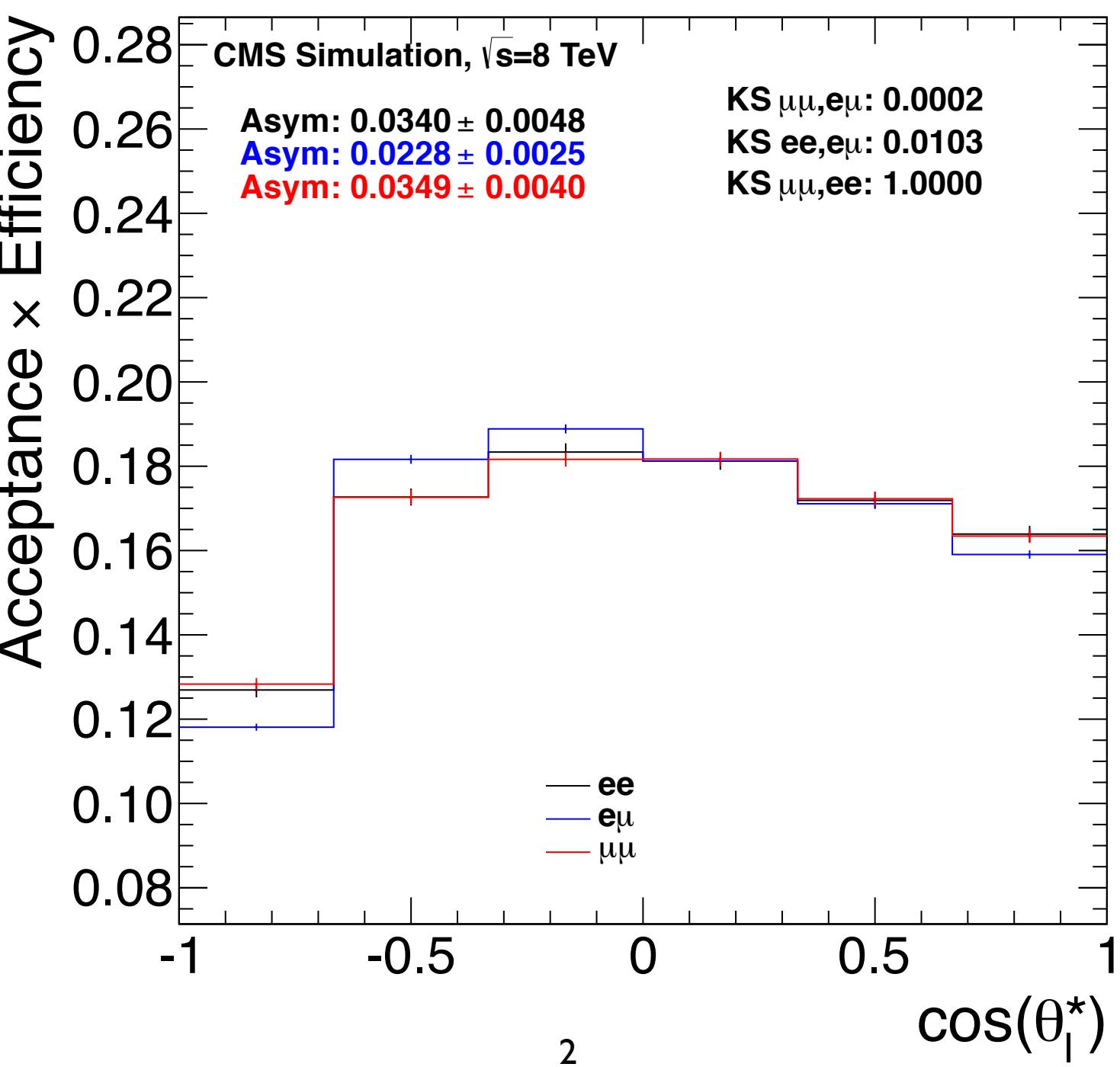
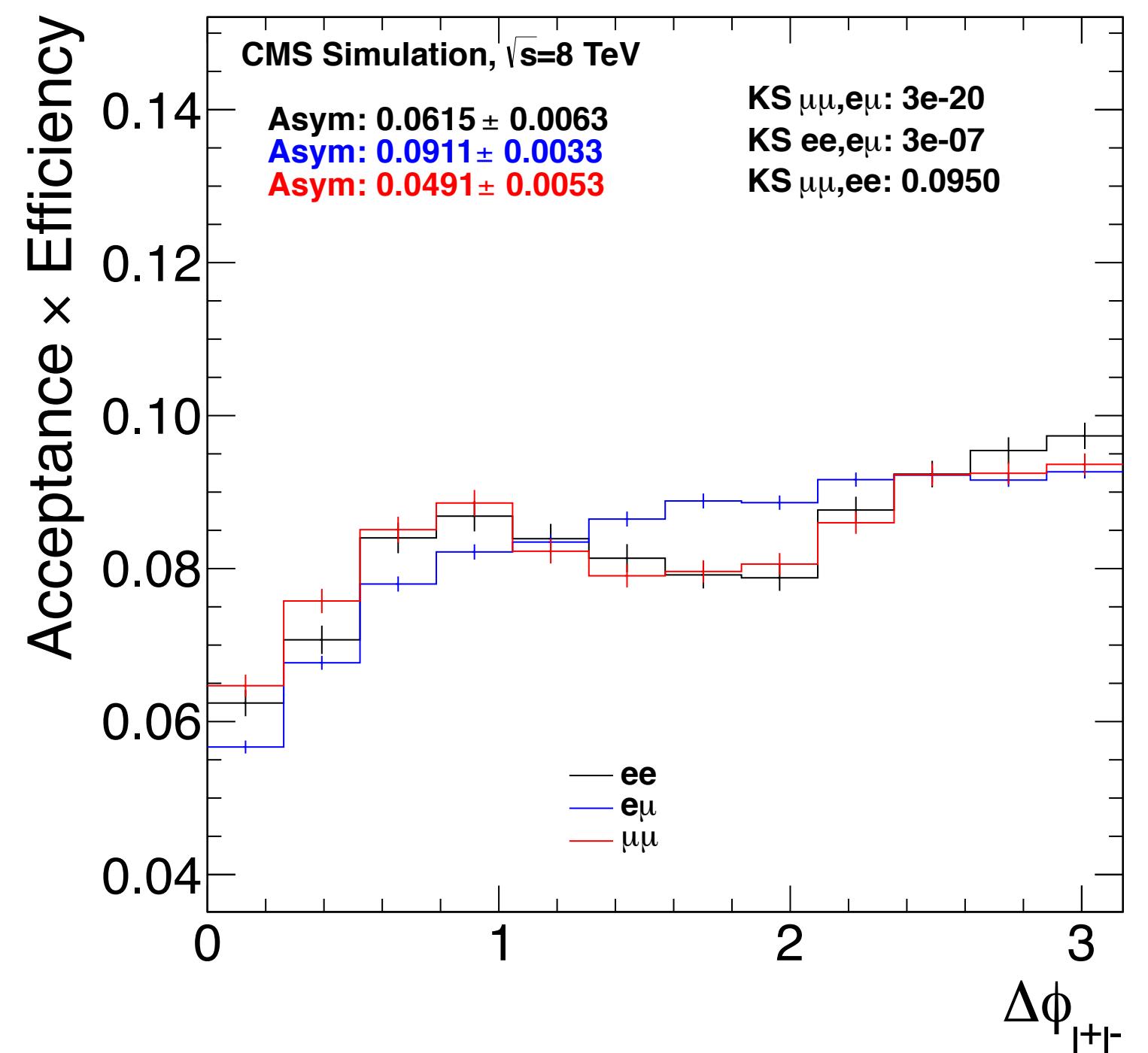
# Plots for AFB chat

20/08/14

New plots from slide 11

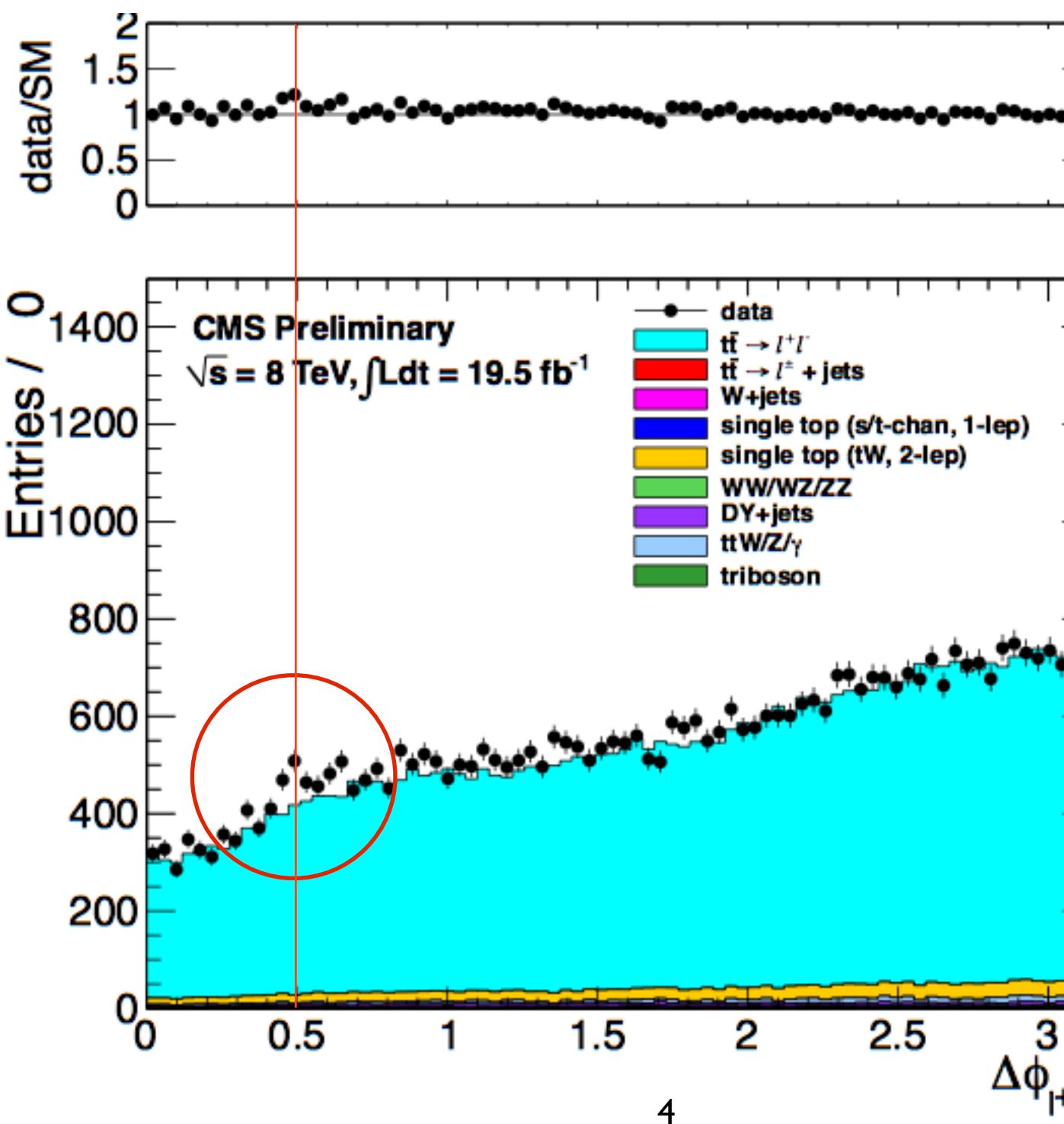
# acceptance vs channel

- The acceptance shape is quite different for SF vs OF due to the extra selection requirements for SF (Z veto and 40 GeV MET cut)
- We know the MC doesn't get the relative fractions in the channels quite right, so splitting the channels makes sense and should reduce our systematics (this is a precision measurement after all)

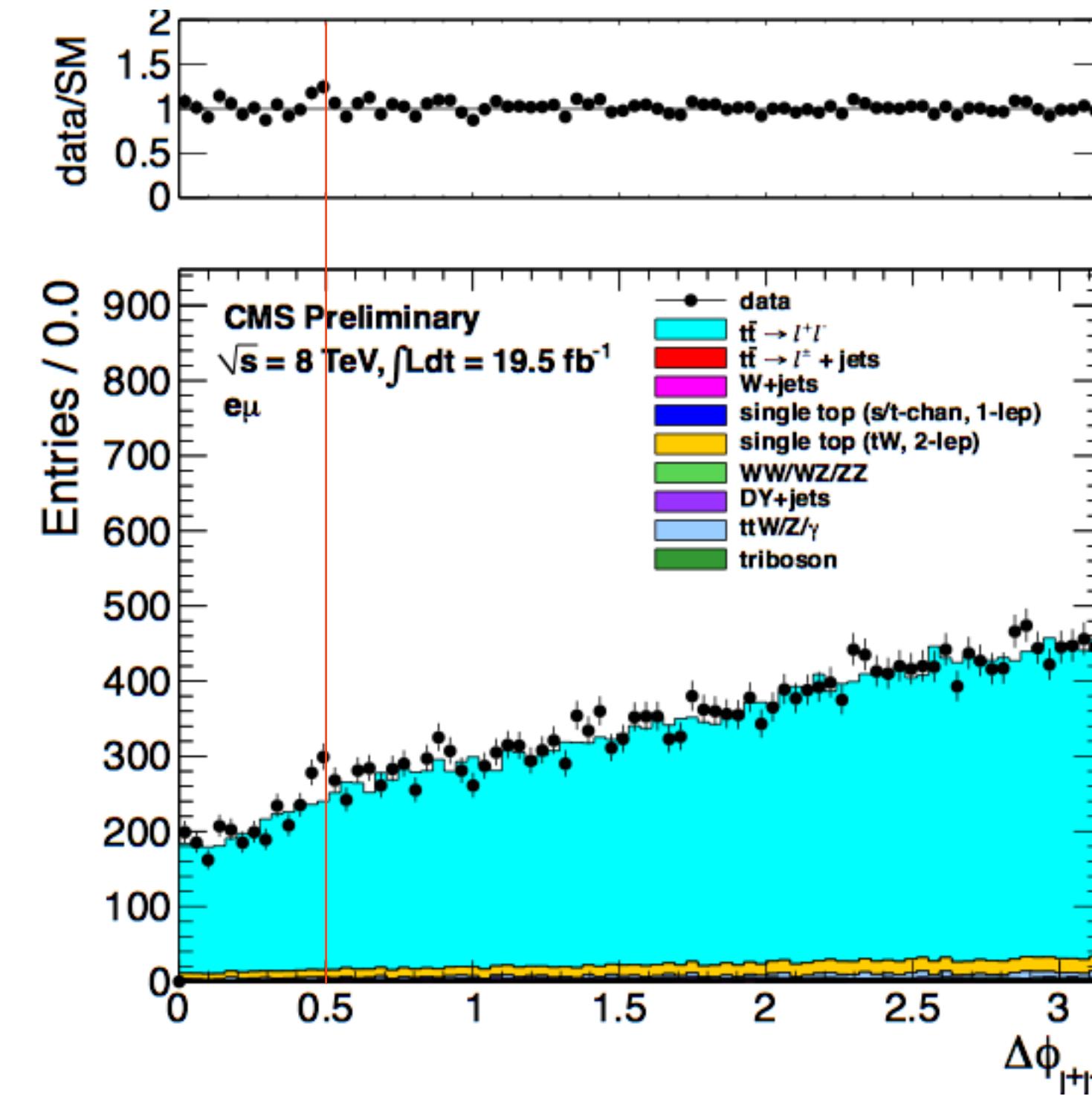
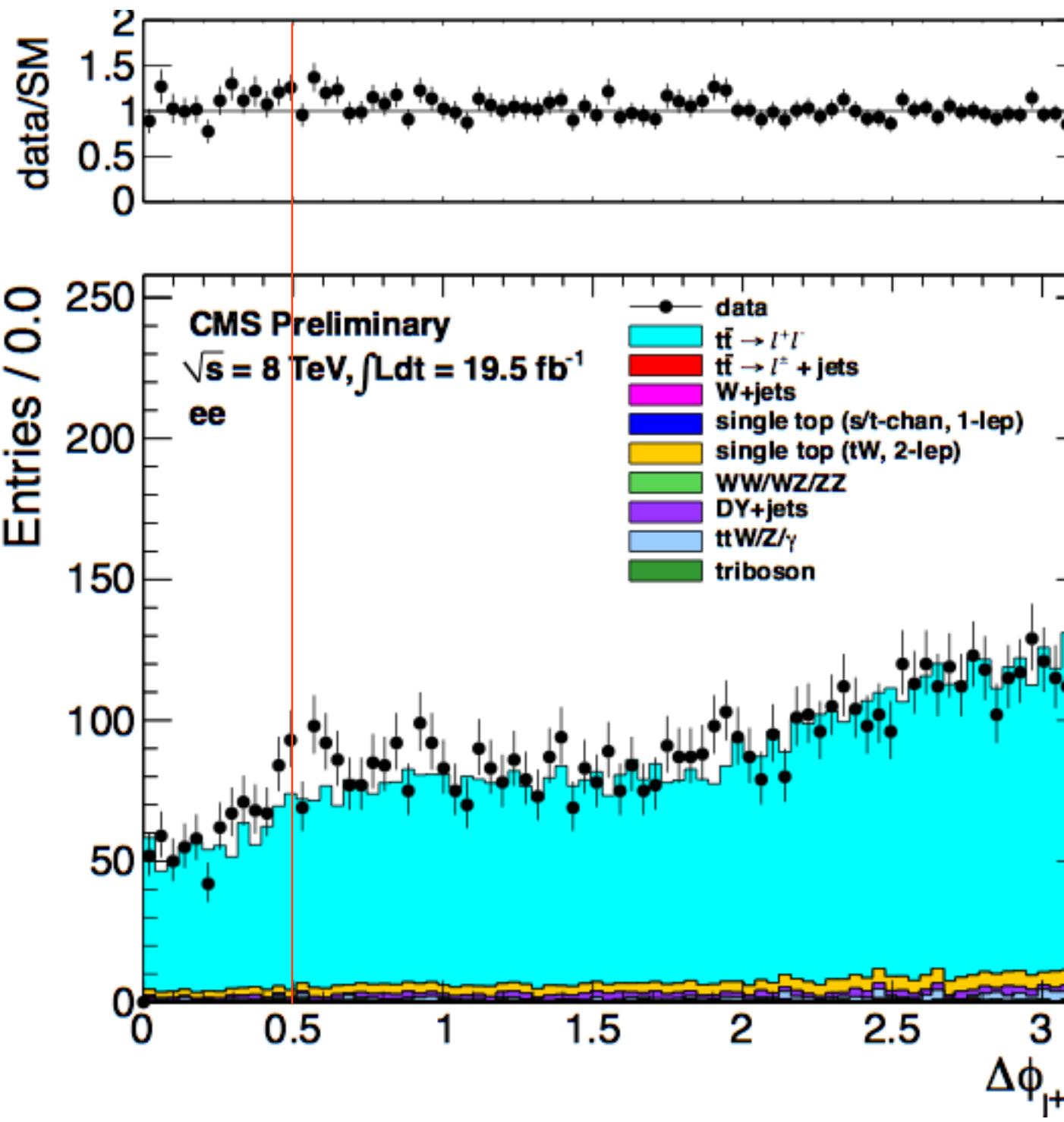
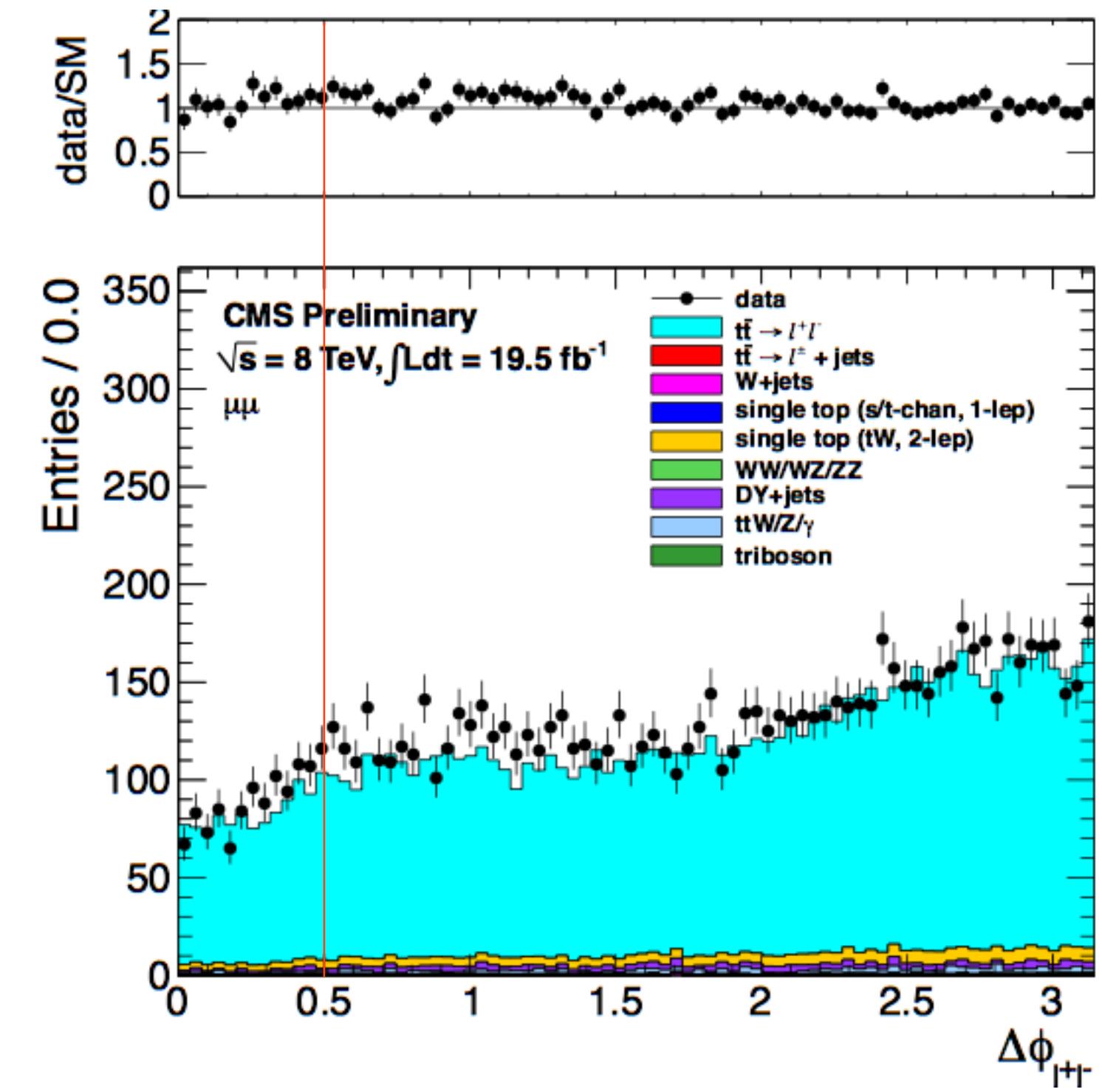


# $\Delta\phi$ “bump” plots

# Full selection, channels combined

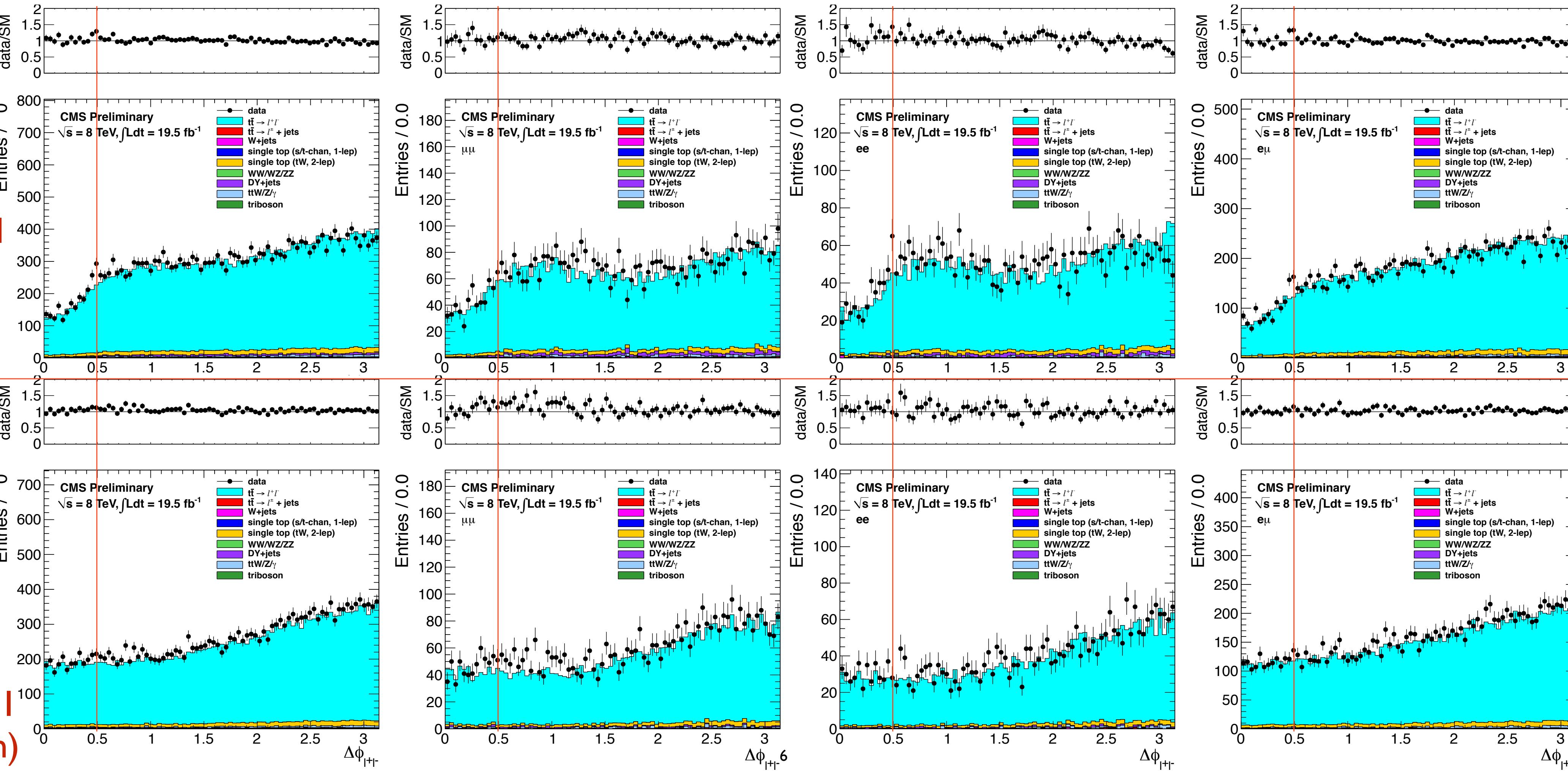


# Full selection, $\mu\mu$ , $ee$ , $e\mu$



Next slide: split into  $\Delta\eta < 1$  (top) and  $> 1$  (bottom): the effect seems to be enhanced in leptons close together in eta

$\Delta\eta < |$   
(top)



$\Delta\eta > |$   
(bottom)

- The effect also seems to be correlated with the number of b-tags (next slide)
- However, it has nothing to do with semi-leptonic bs or lepton-jet overlap removal
  - tested this thoroughly
- 0-btag sample has only ~50% ttbar, compared with ~90% for >0 b-tags
  - effect is correlated with some kinematic/topological feature of ttbar events?

# mueg interactive plots vs nbtags

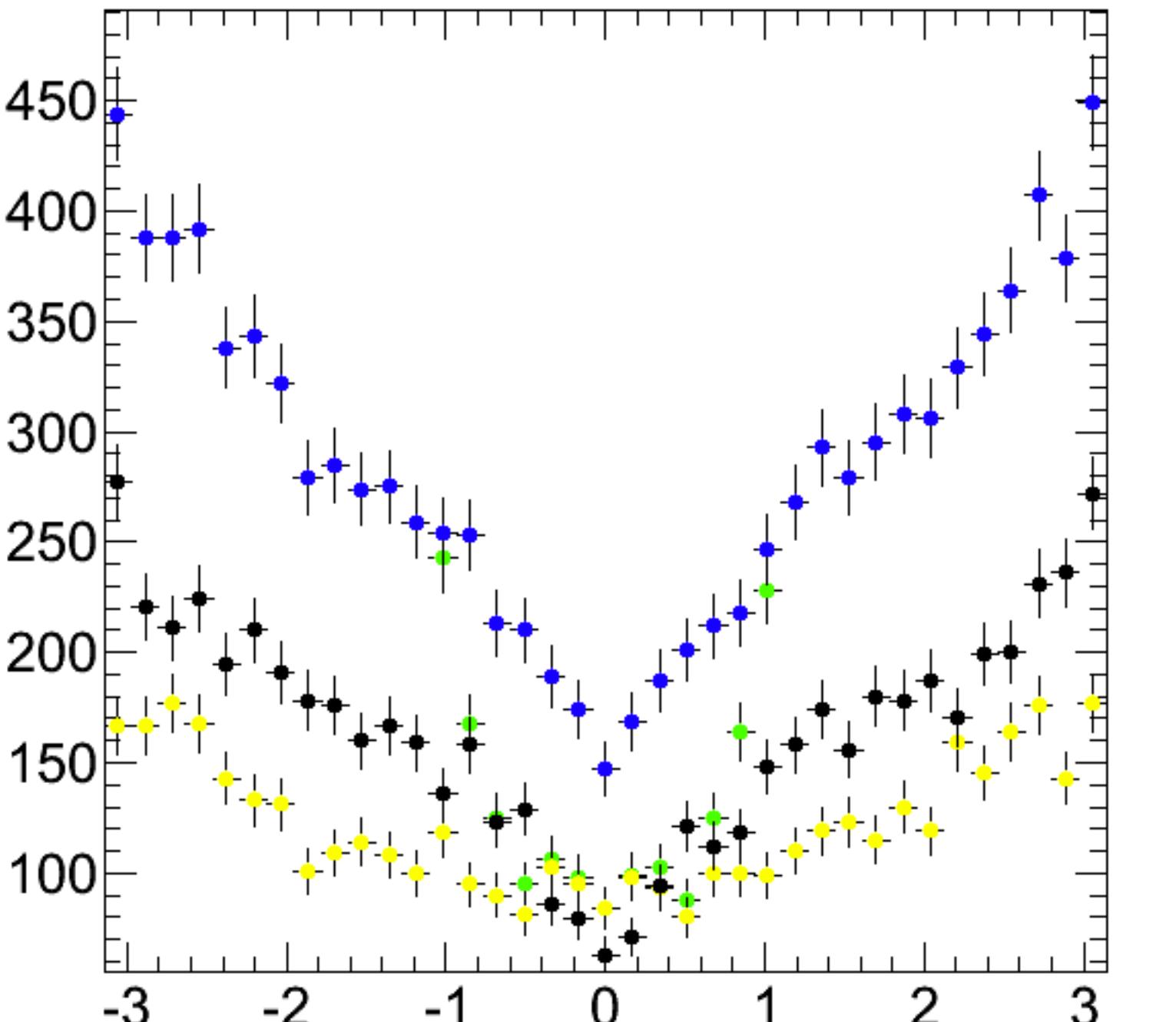
inclusive  
 $\Delta R > 1$

$\Delta\eta > 1$

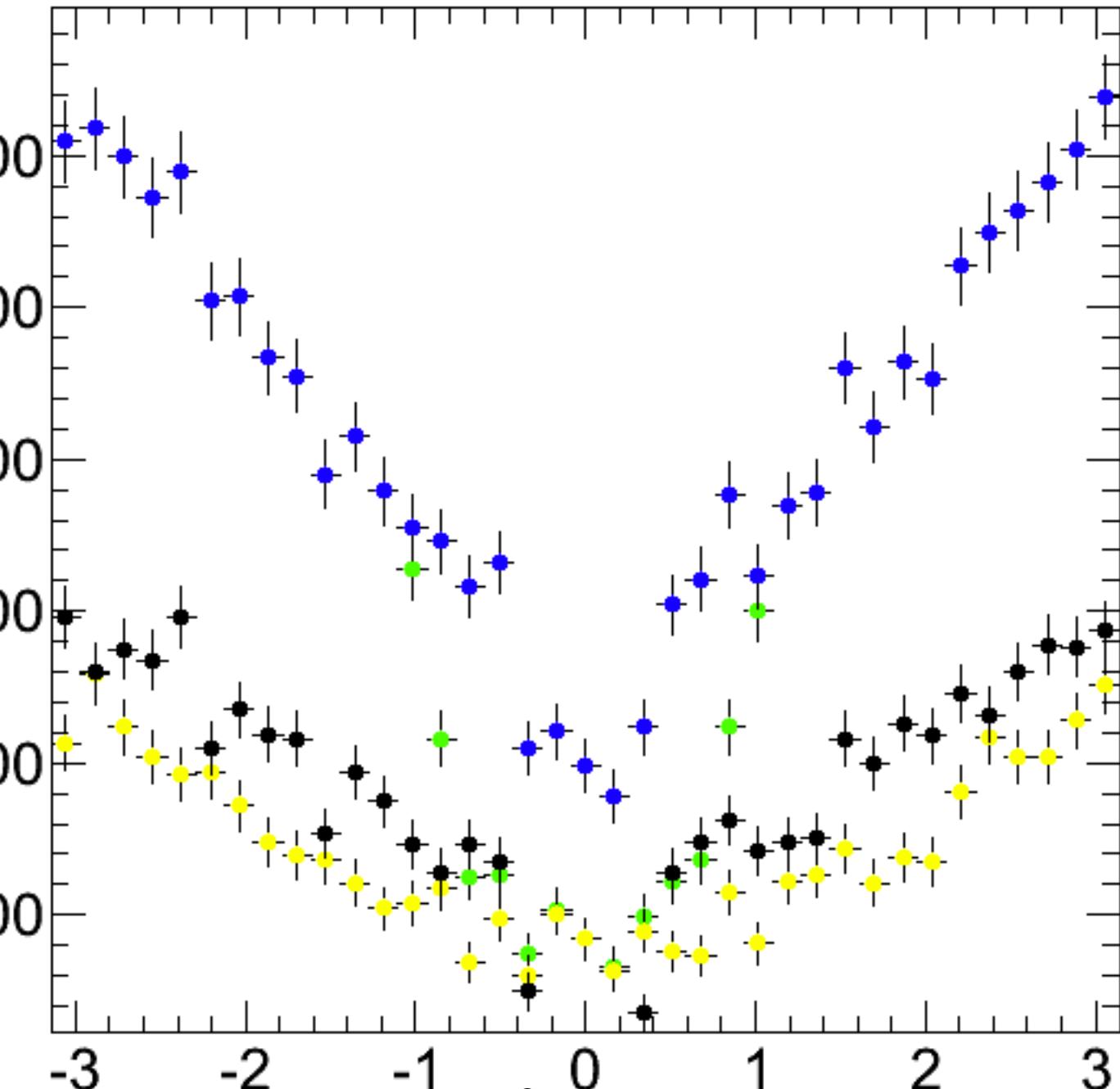
$\Delta\eta < 1$

```
t.Draw("(2*asin(sin(lep1.Phi())/2-lep2.Phi()/2))>>hj2", "nngoodlep==2 && id1*id2<0 && dilmass > 20 && abs(id1)!=abs(id2) && lep2.Pt()>20 && nbtagscsvm ==x && sqrt([0,1]*acos(cos(lep1.Phi())-lep2.Phi()))^2 + (lep1.Eta()-lep2.Eta())^2) [>,<] [0,1]", "PEsame")
```

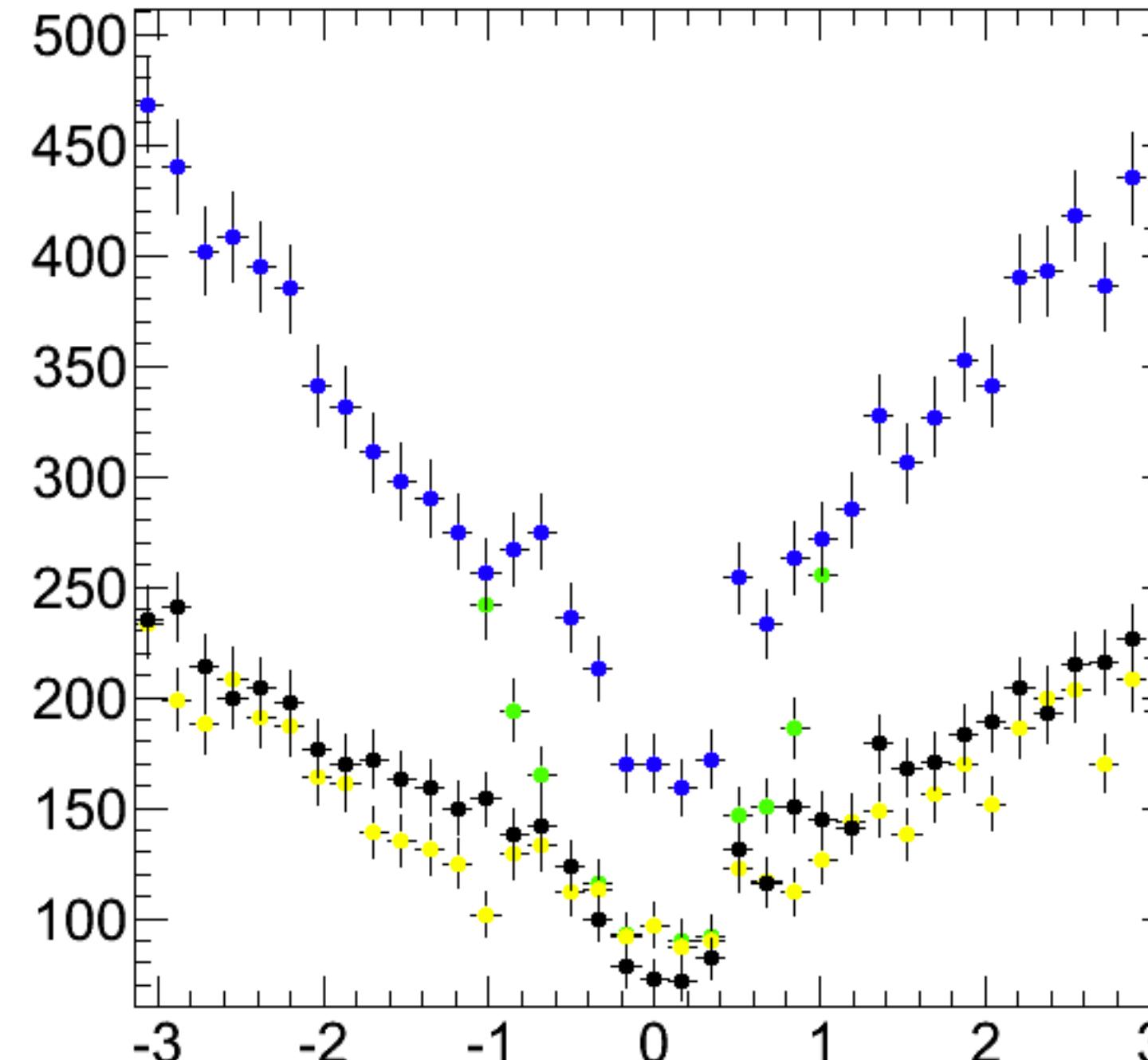
nbtagscsvm==0



nbtagscsvm==1



nbtagscsvm==2



# mueg interactive plots vs nbtags

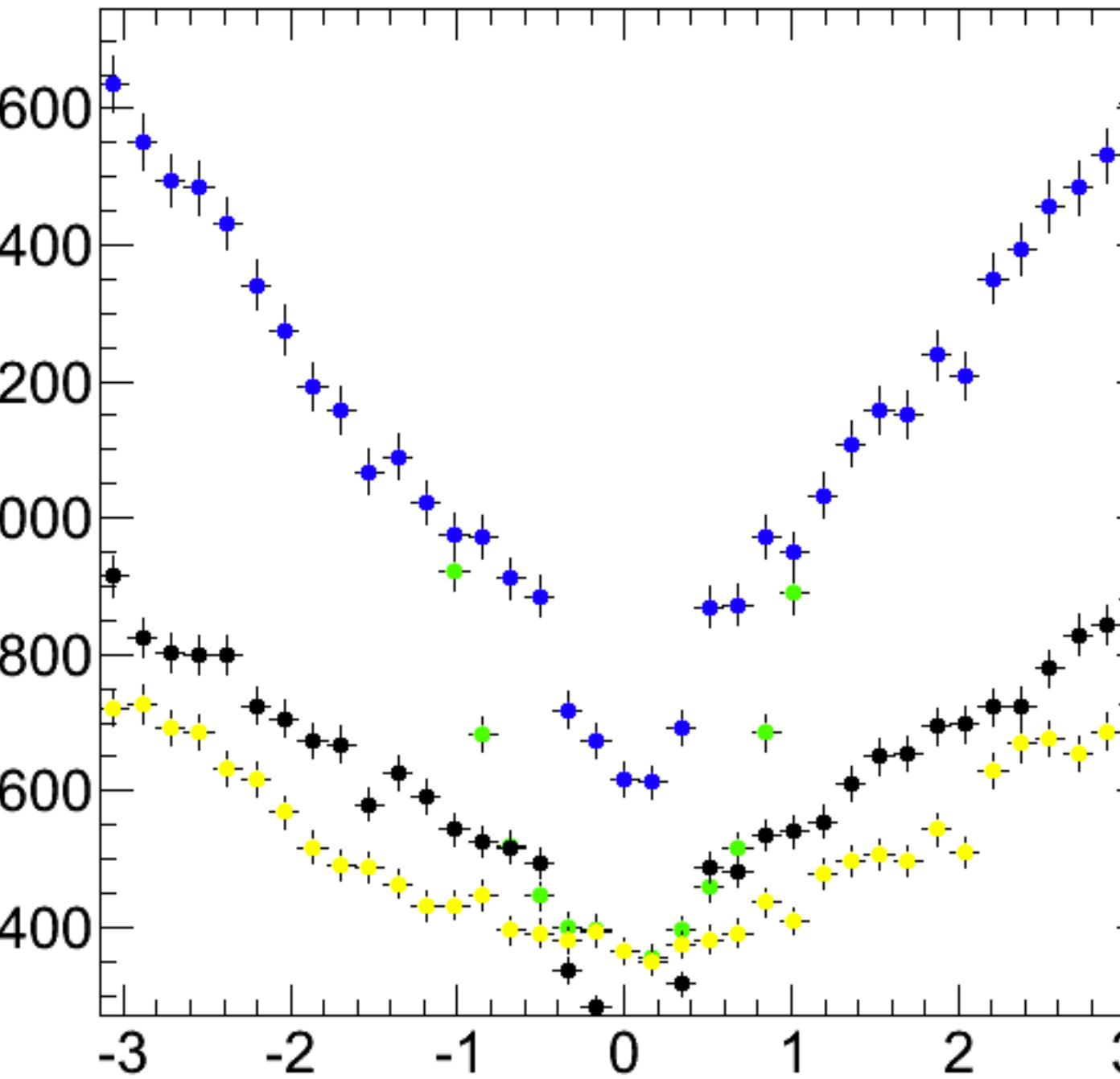
inclusive  
 $\Delta R > 1$

$\Delta\eta > 1$

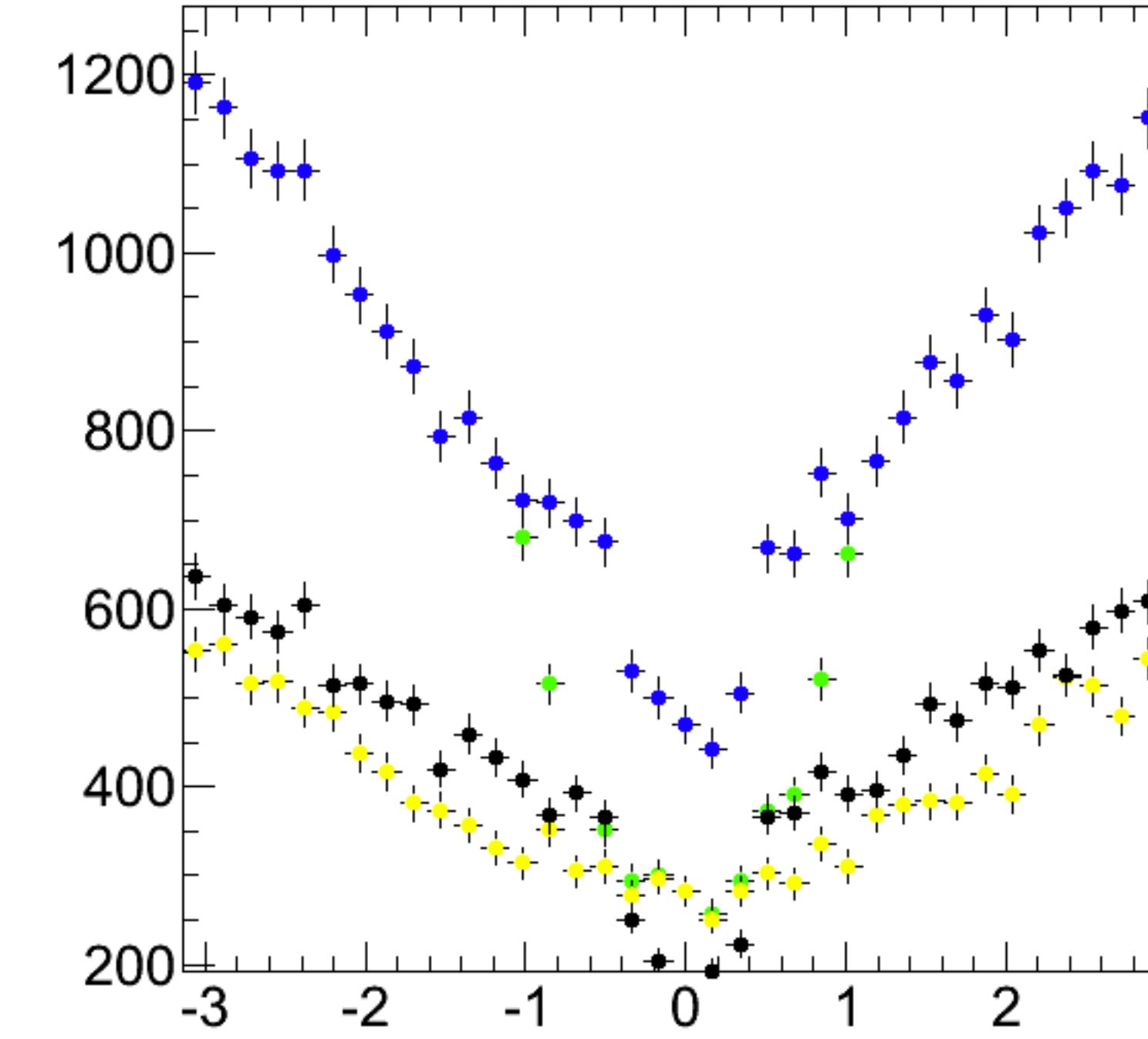
$\Delta\eta < 1$

```
t.Draw("(2*asin(sin(lep1.Phi())/2-lep2.Phi()/2))>>hj2", "ngoodlep==2 && id1*id2<0 && dilmass > 20 && abs(id1)!=abs(id2) && lep2.Pt()>20 && nbtagscsvm ==x && sqrt([0,1]*acos(cos(lep1.Phi())-lep2.Phi()))^2 + (lep1.Eta()-lep2.Eta())^2) [,<] [0,1]", "PEsame")
```

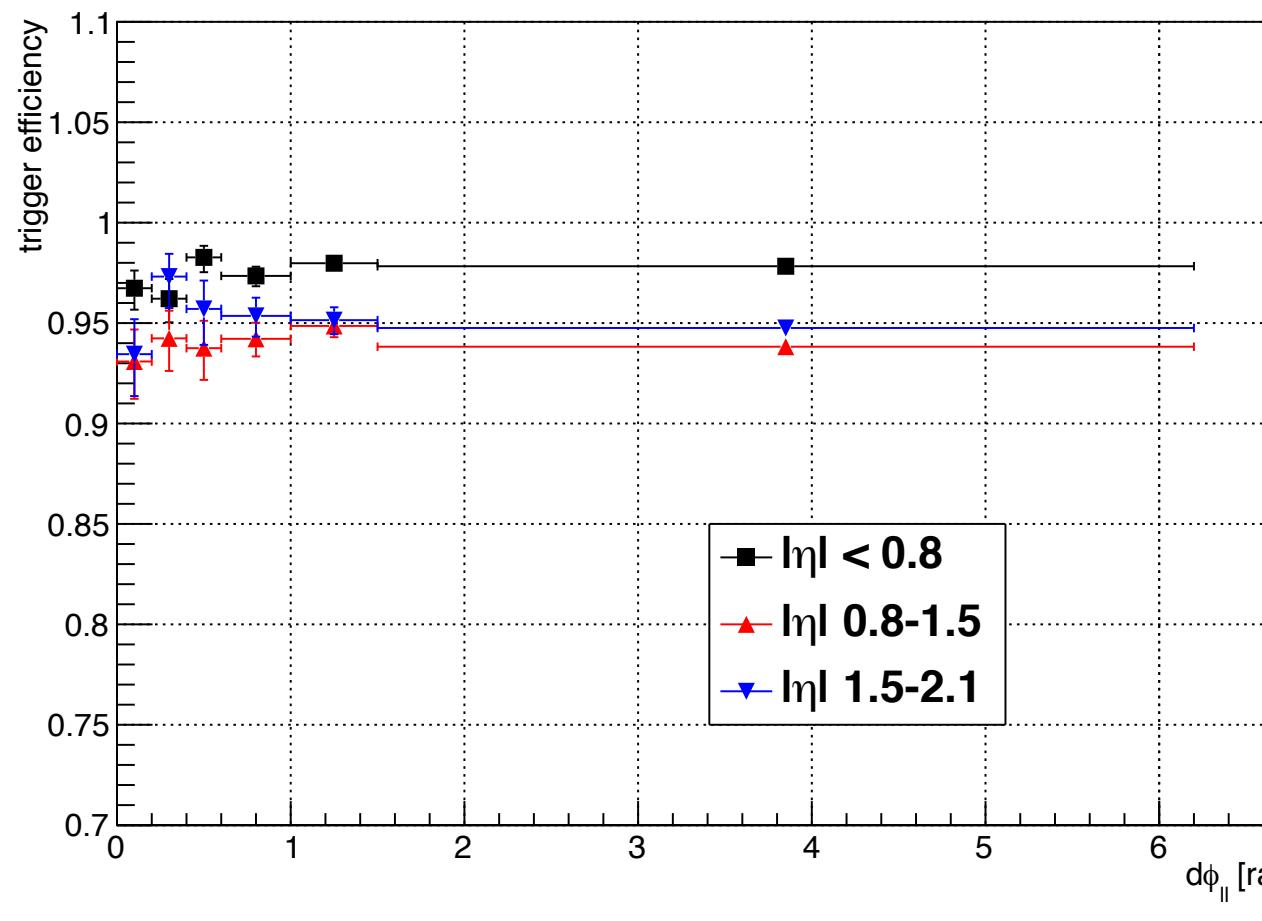
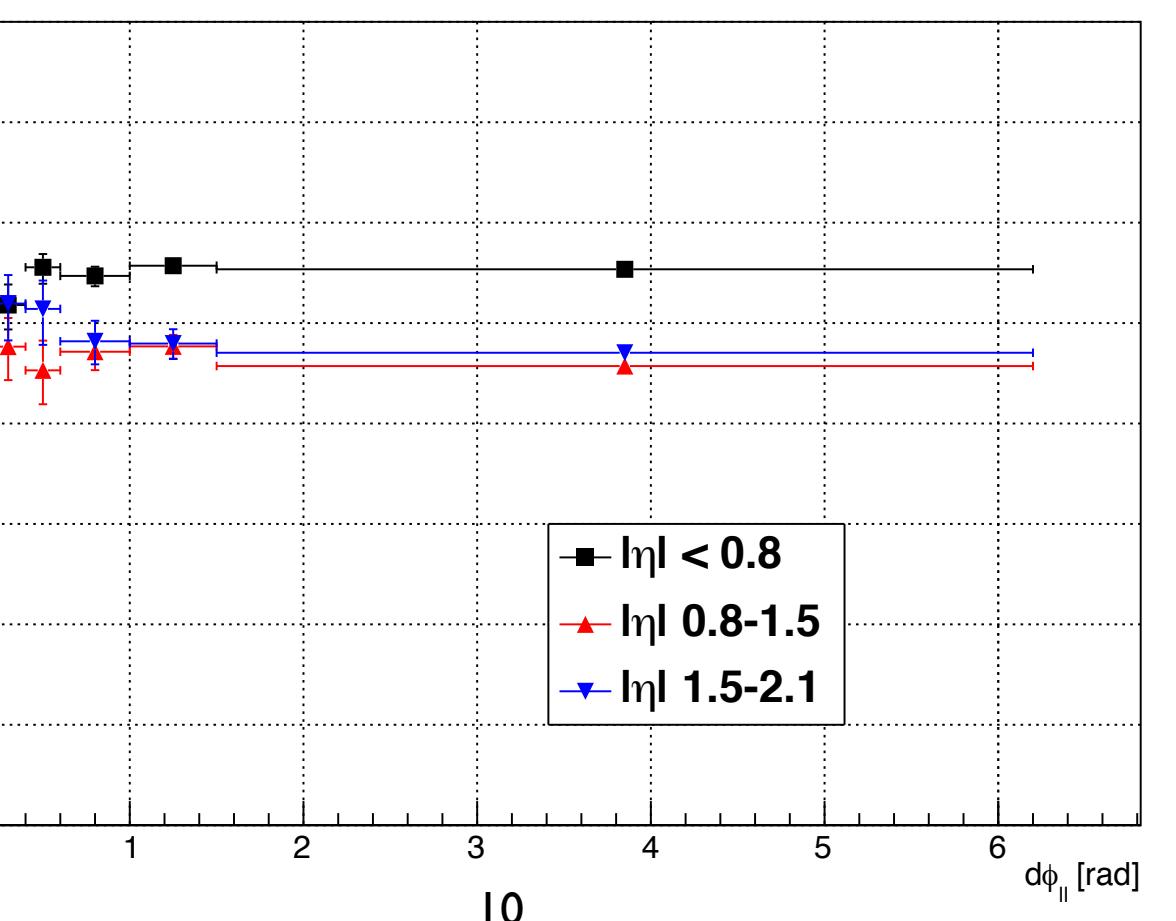
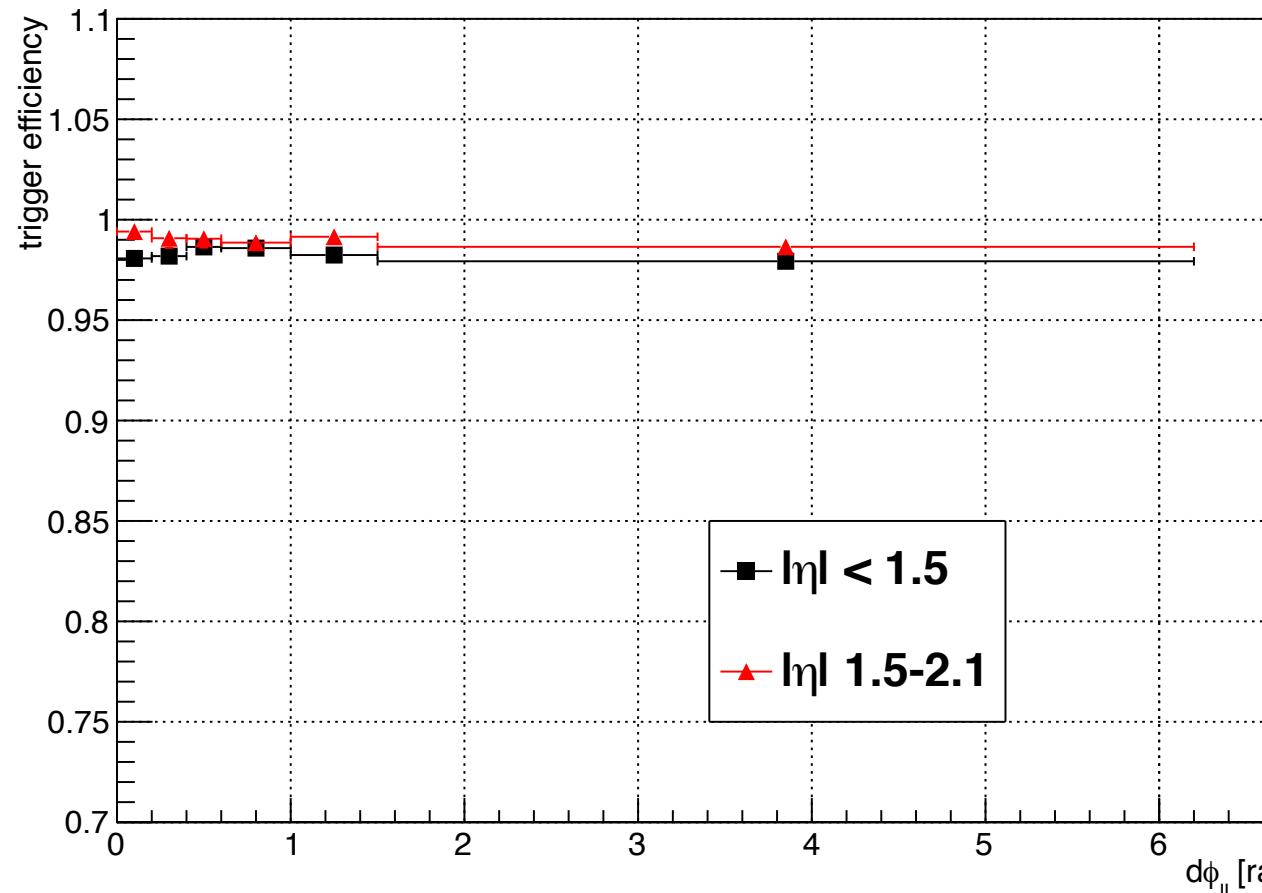
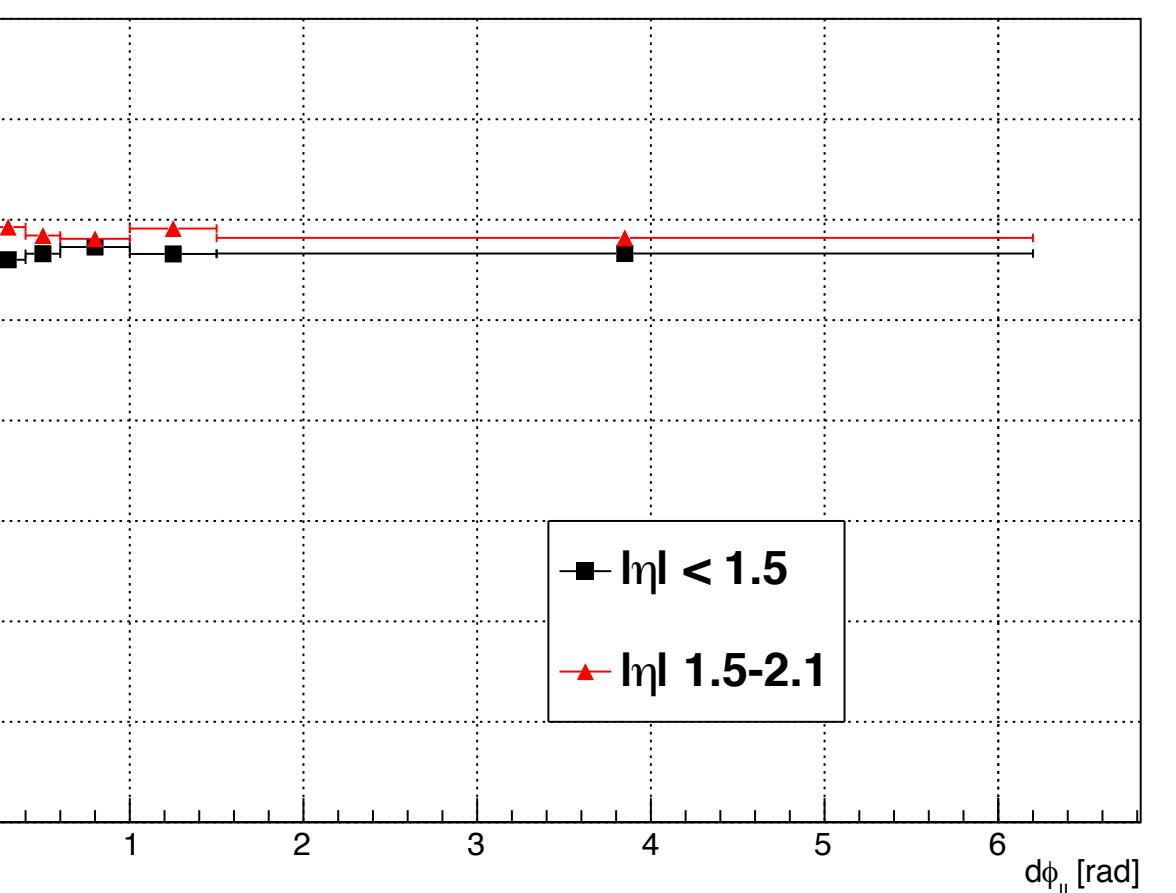
inclusive



nbtagscsvm>0

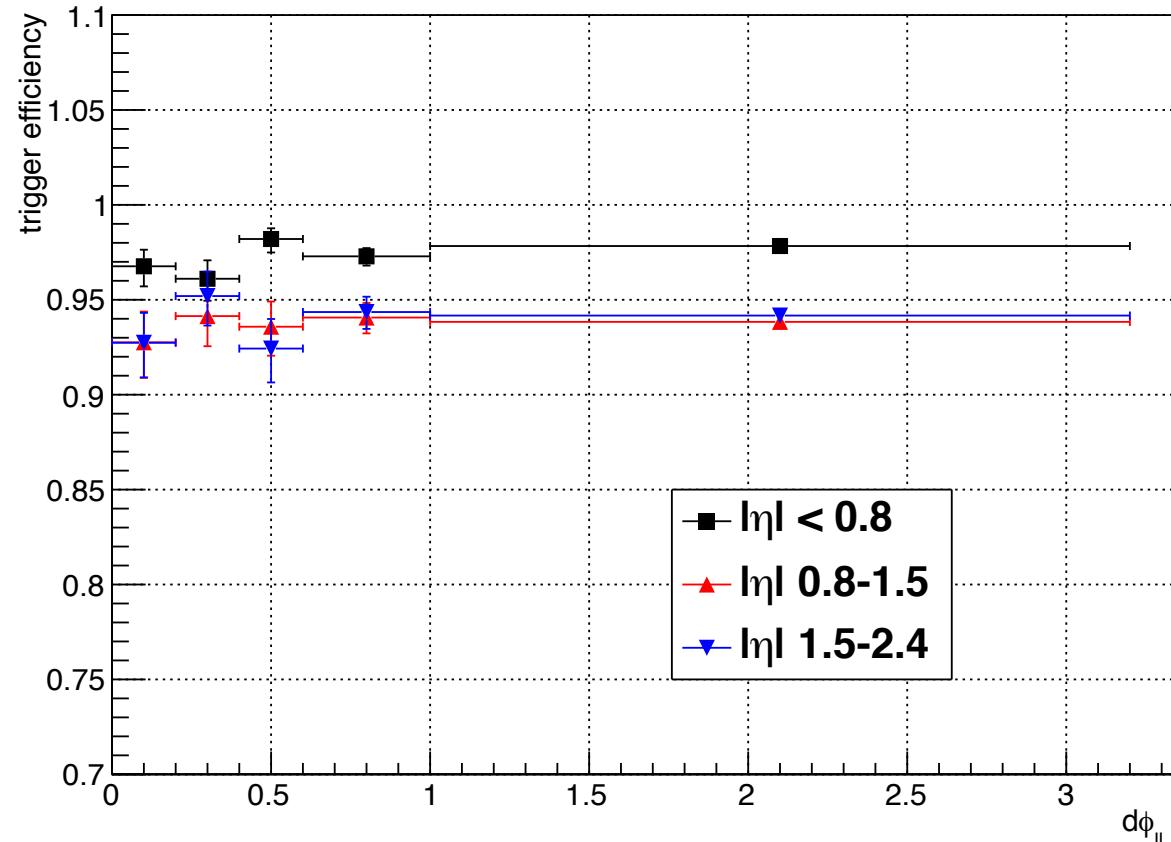
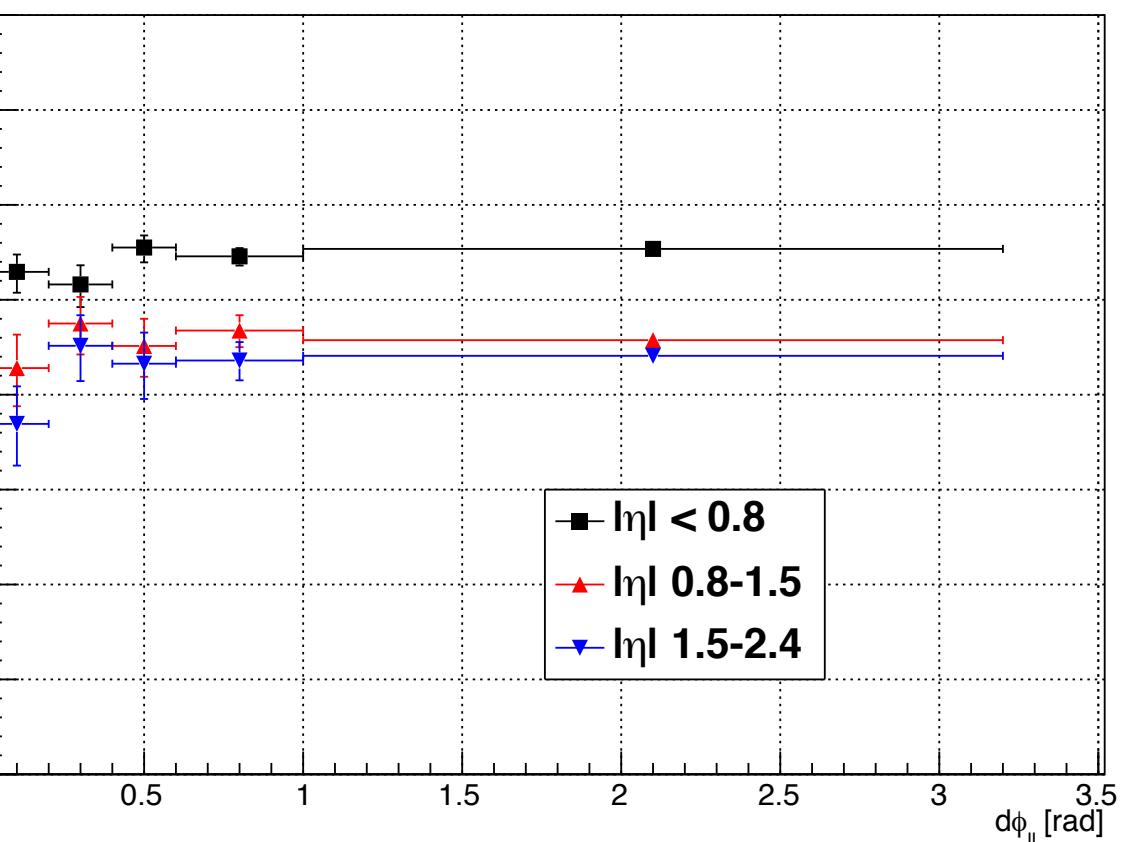
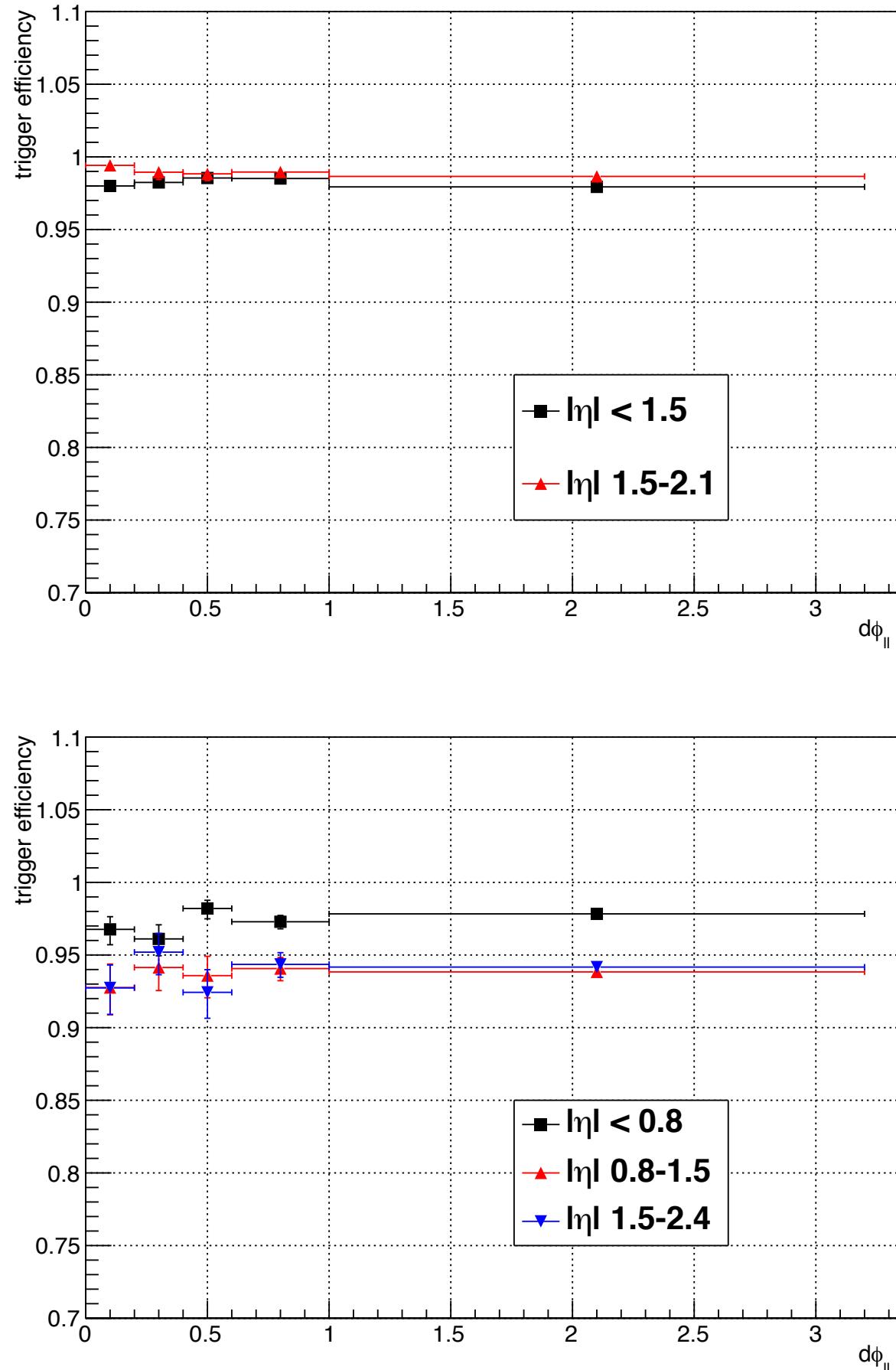
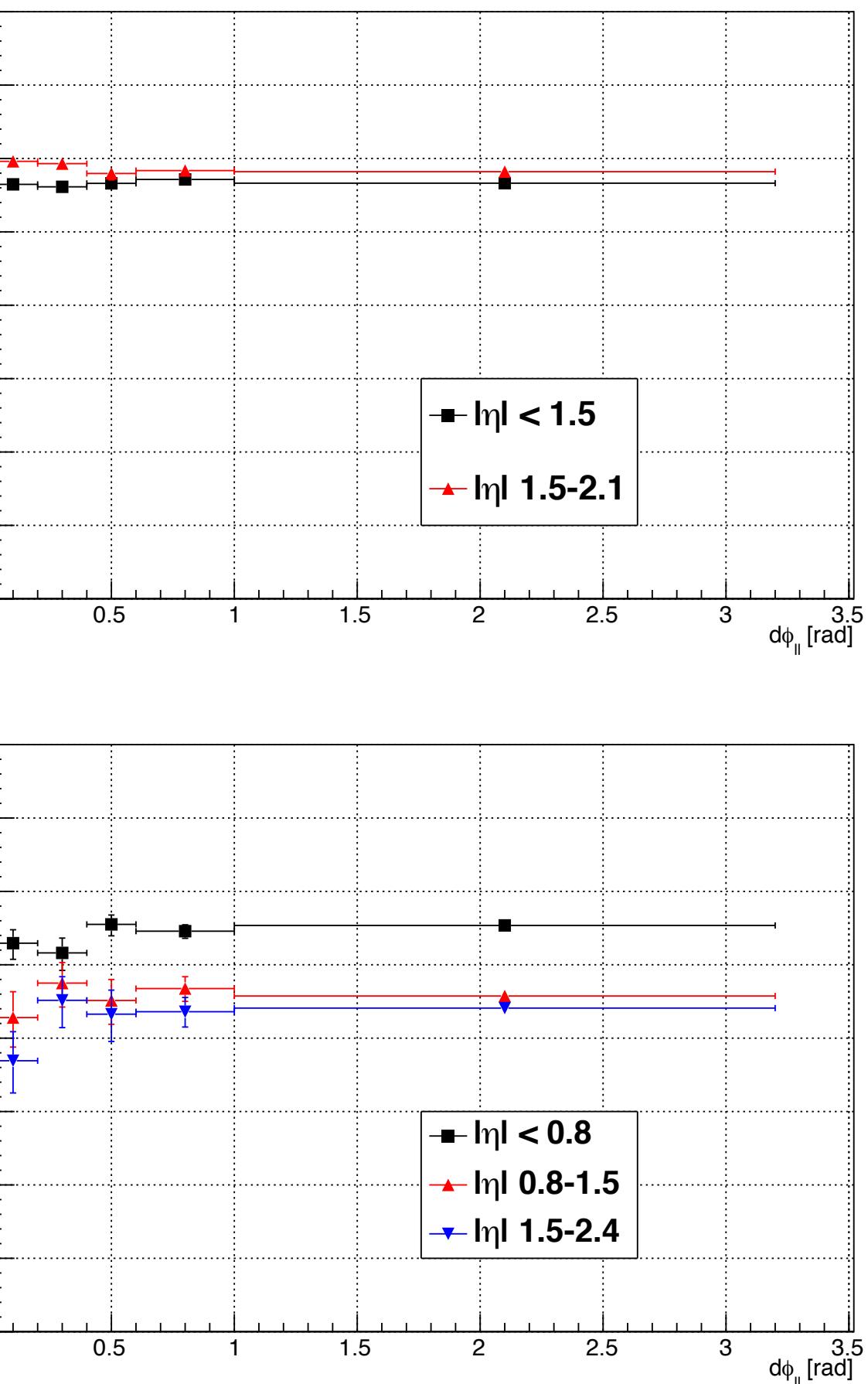


- Trigger efficiency vs  $\Delta\phi$  (Run2012A)
  - Top: electrons
  - Bottom: muons
  - Left: leading leg
  - Right: trailing leg
  - There is arguably some structure at low  $\Delta\phi$  for muons

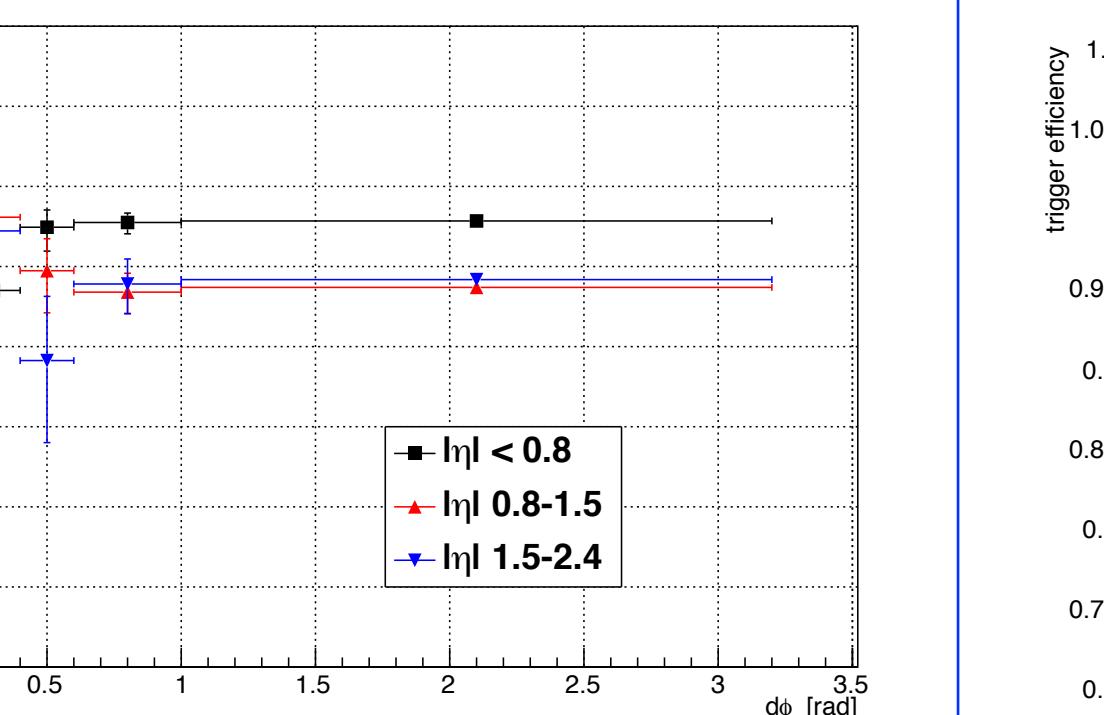
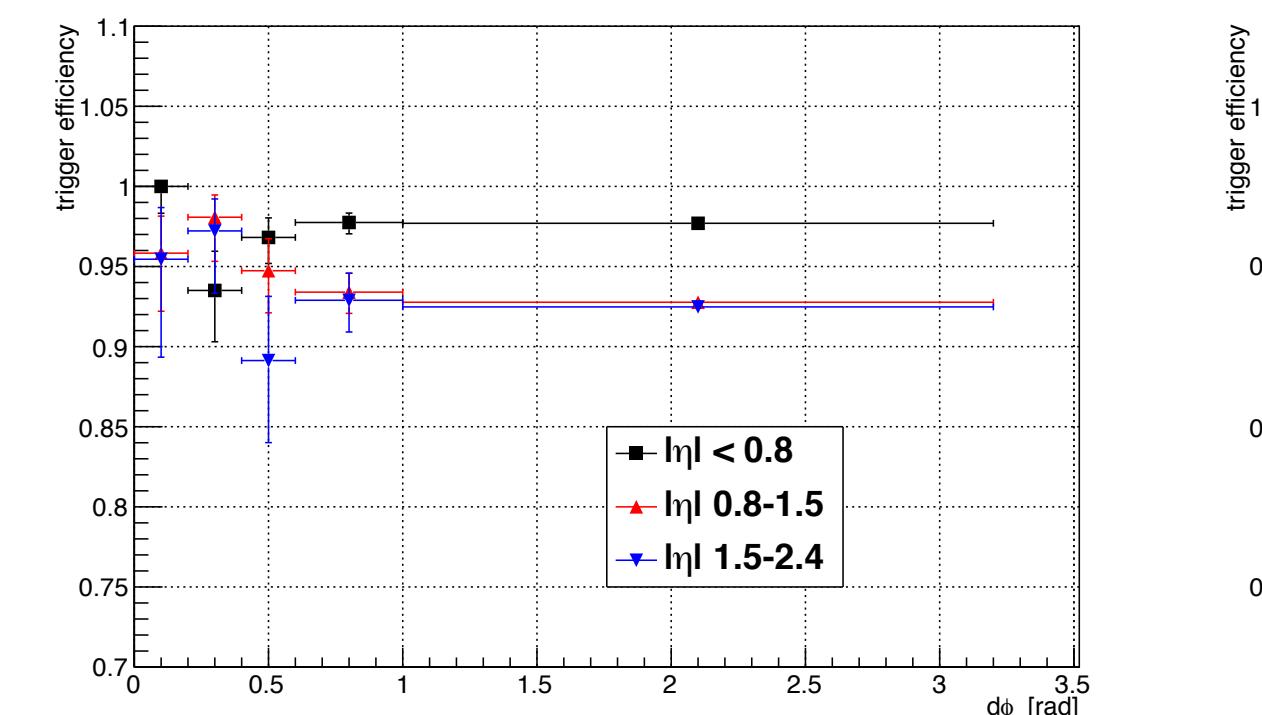
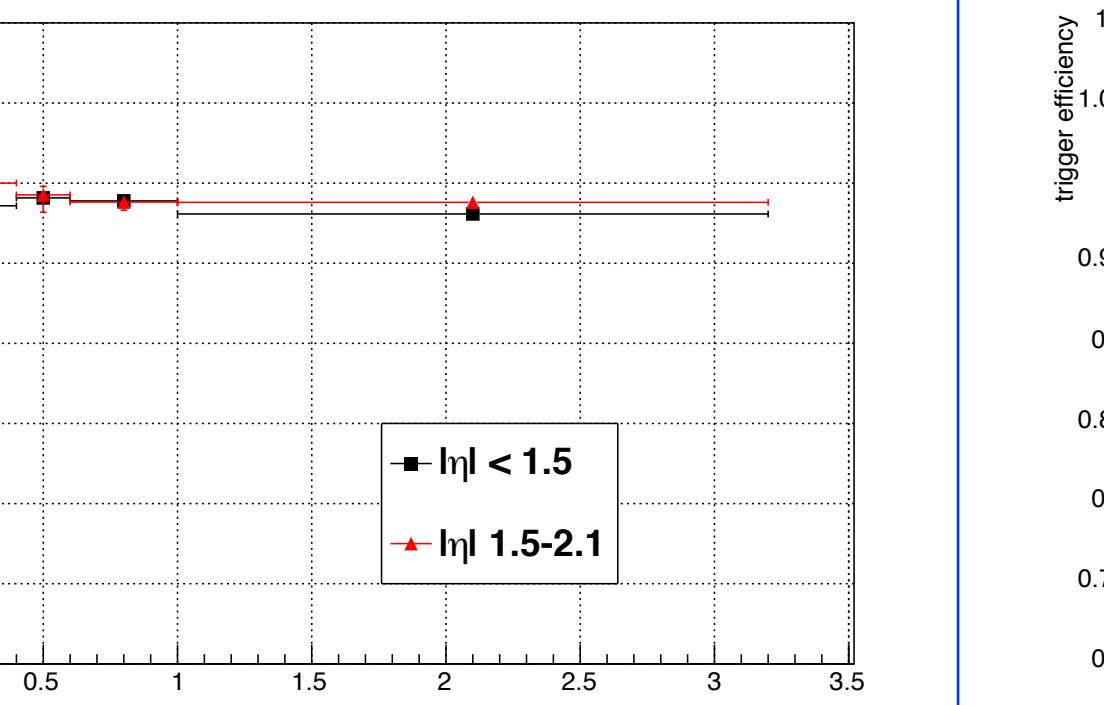
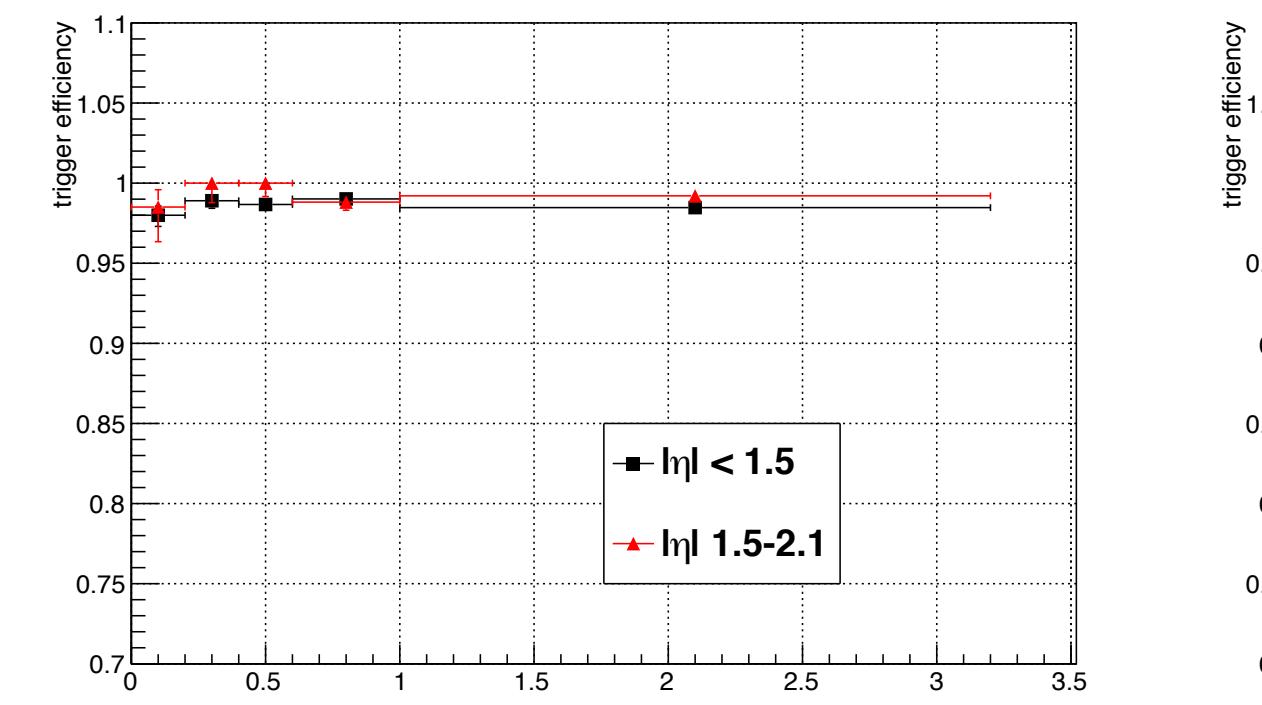


## Inclusive in dEta

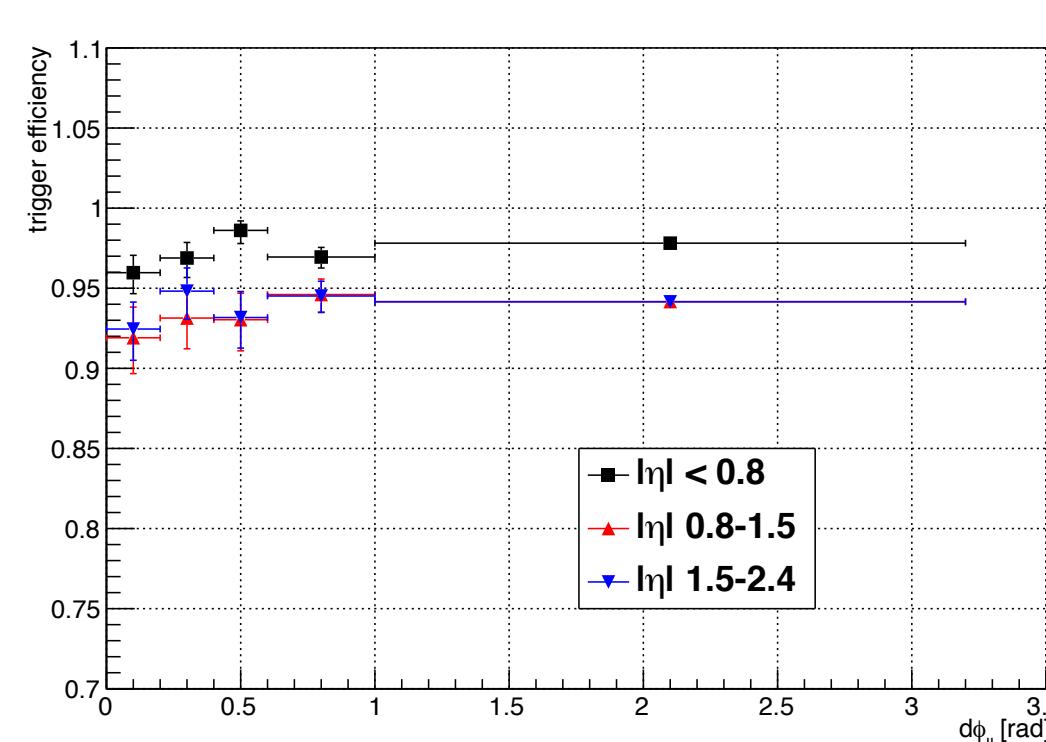
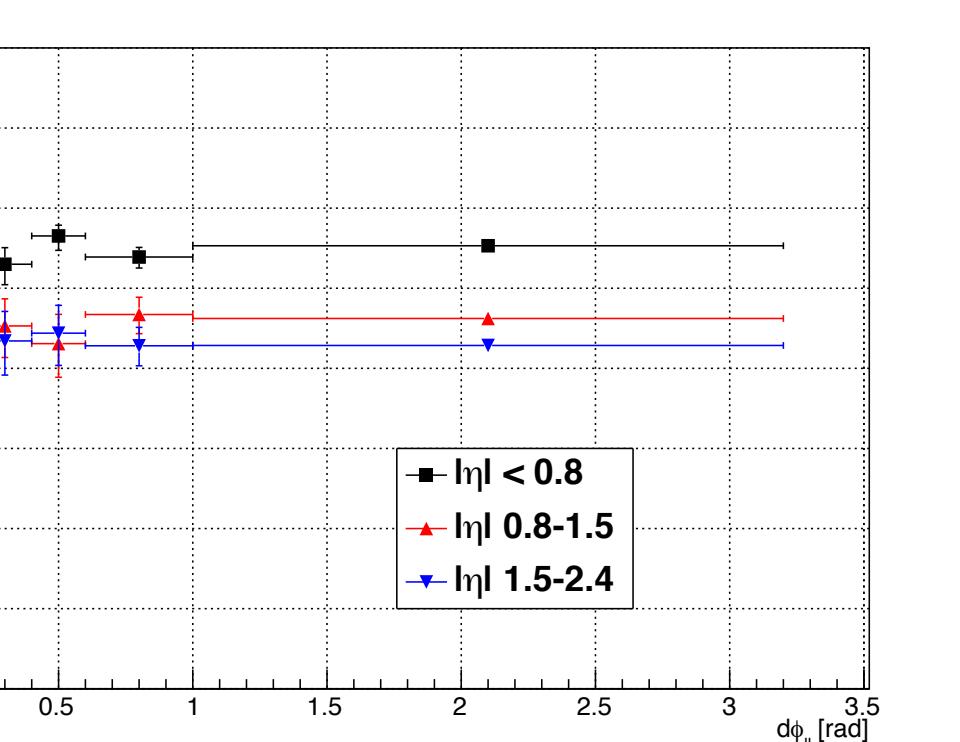
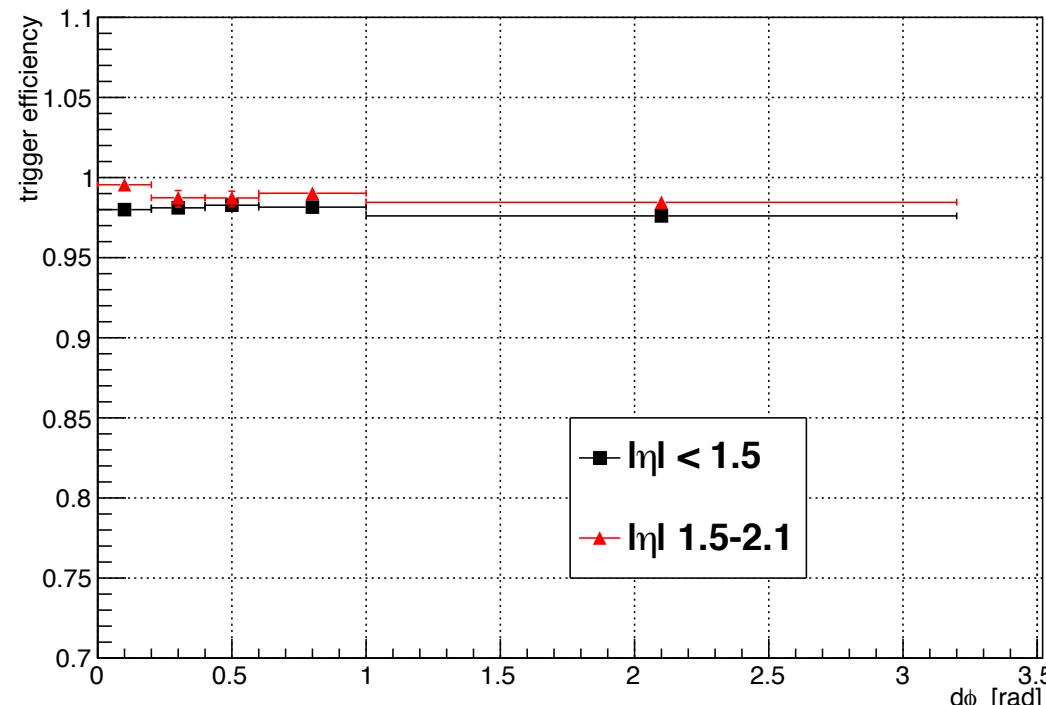
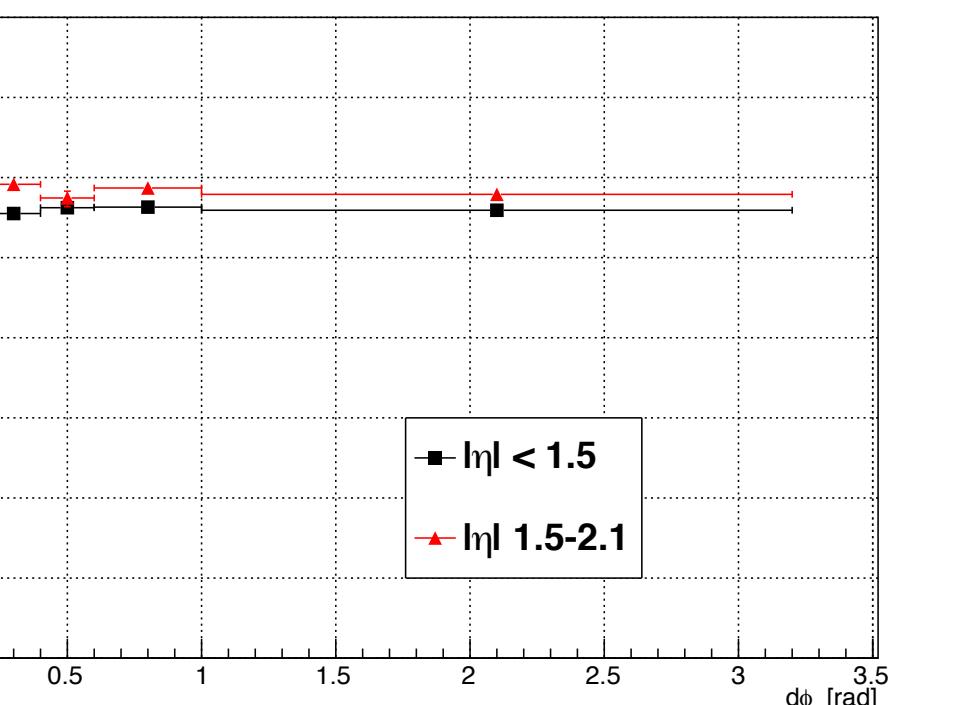
- Updated results (20th Aug)
  - dPhi from 0 to  $\pi$  and different binning and
  - Split dEta<| $\eta$ | and dEta>| $\eta$ | on next slide
  - No smoking gun



$d\text{Eta} < 1.0$



$d\text{Eta} > 1.0$



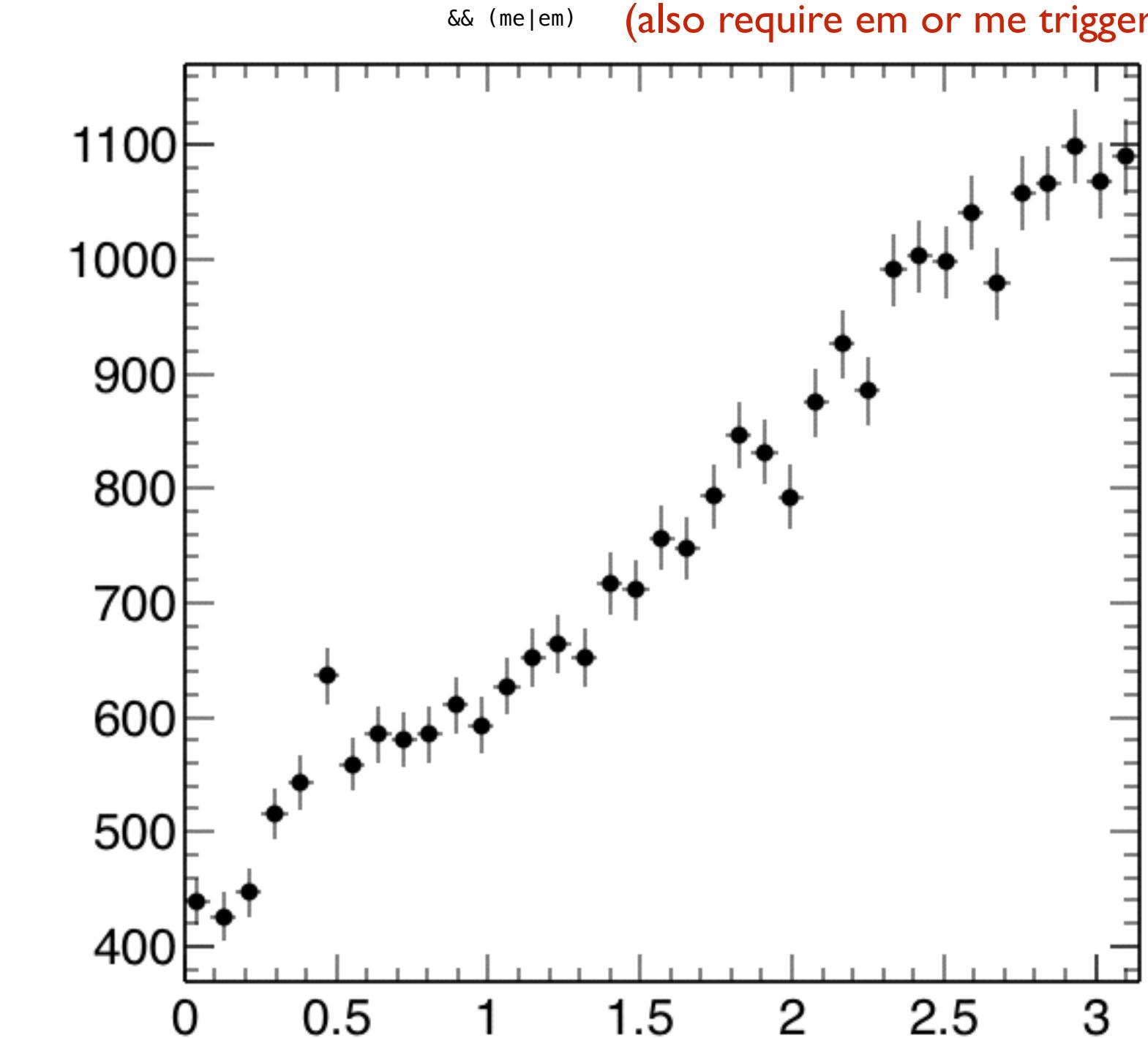
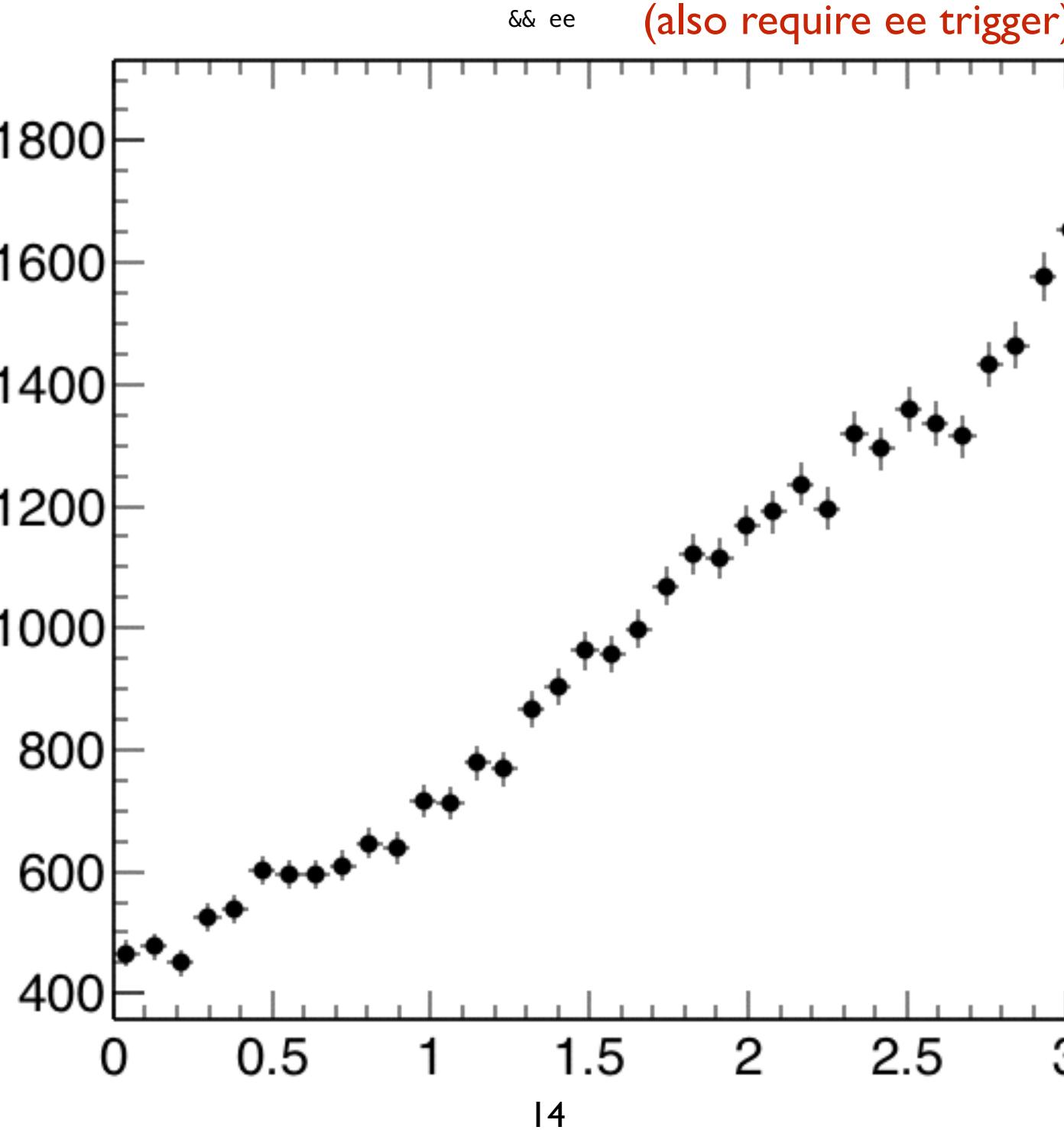
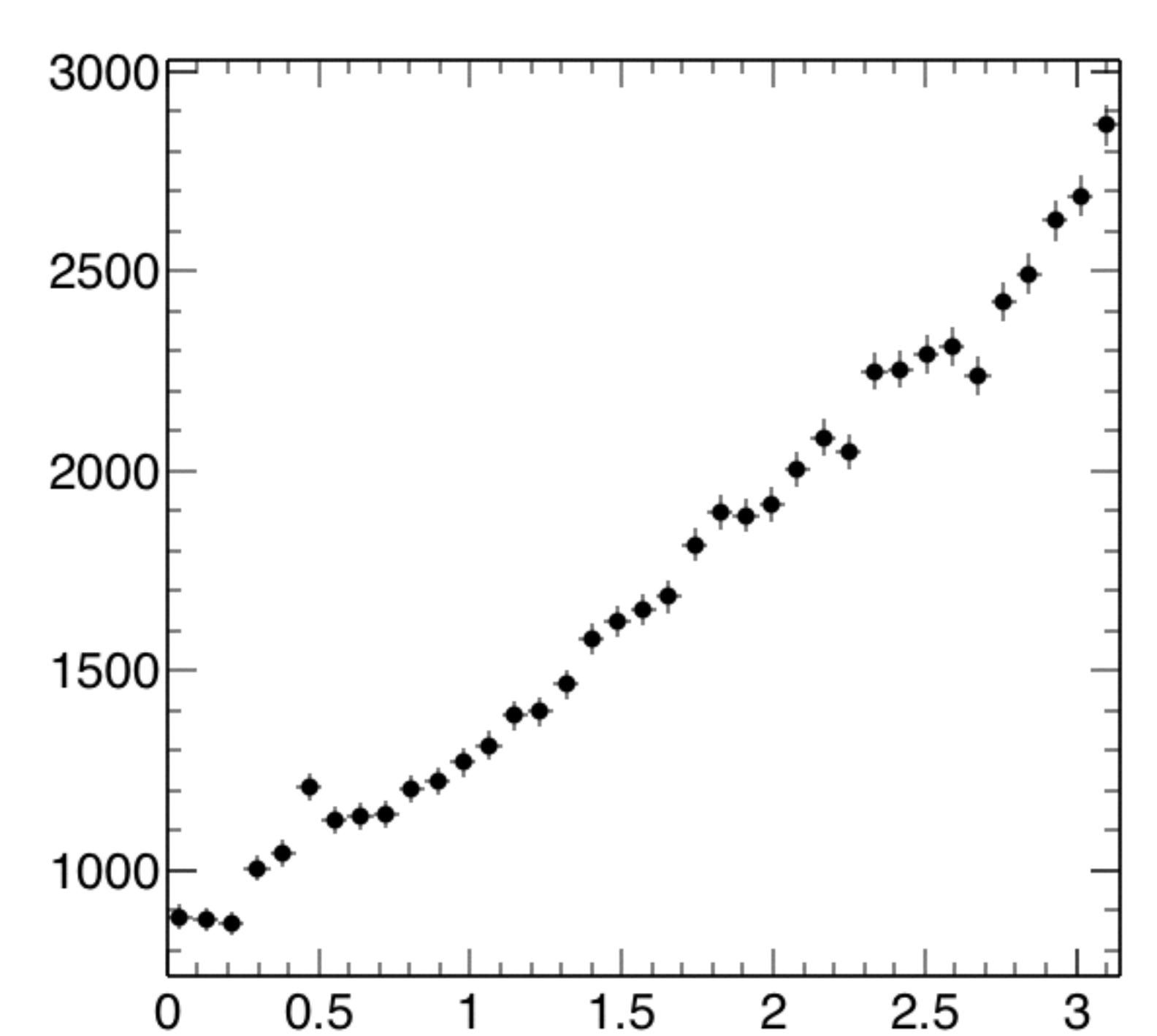
# Plots using single lepton datasets (new)

- Plots all show  $\Delta\phi(l_+, l_-)$ , folded over so it runs from 0 to  $\pi$ 
  - (the complicated looking formula for deltaPhi is because I was originally looking from  $-\pi$  to  $+\pi$  and seeing if there was any relation to lepton charge)
- On each slide I show a base “Draw” command used to produce the plot on the left, with additional cuts (if any) indicated above each plot with “ $\&&$ ”.
- ee, em, me, and mm are the names of the dilepton triggers

# Single electron dataset and trigger

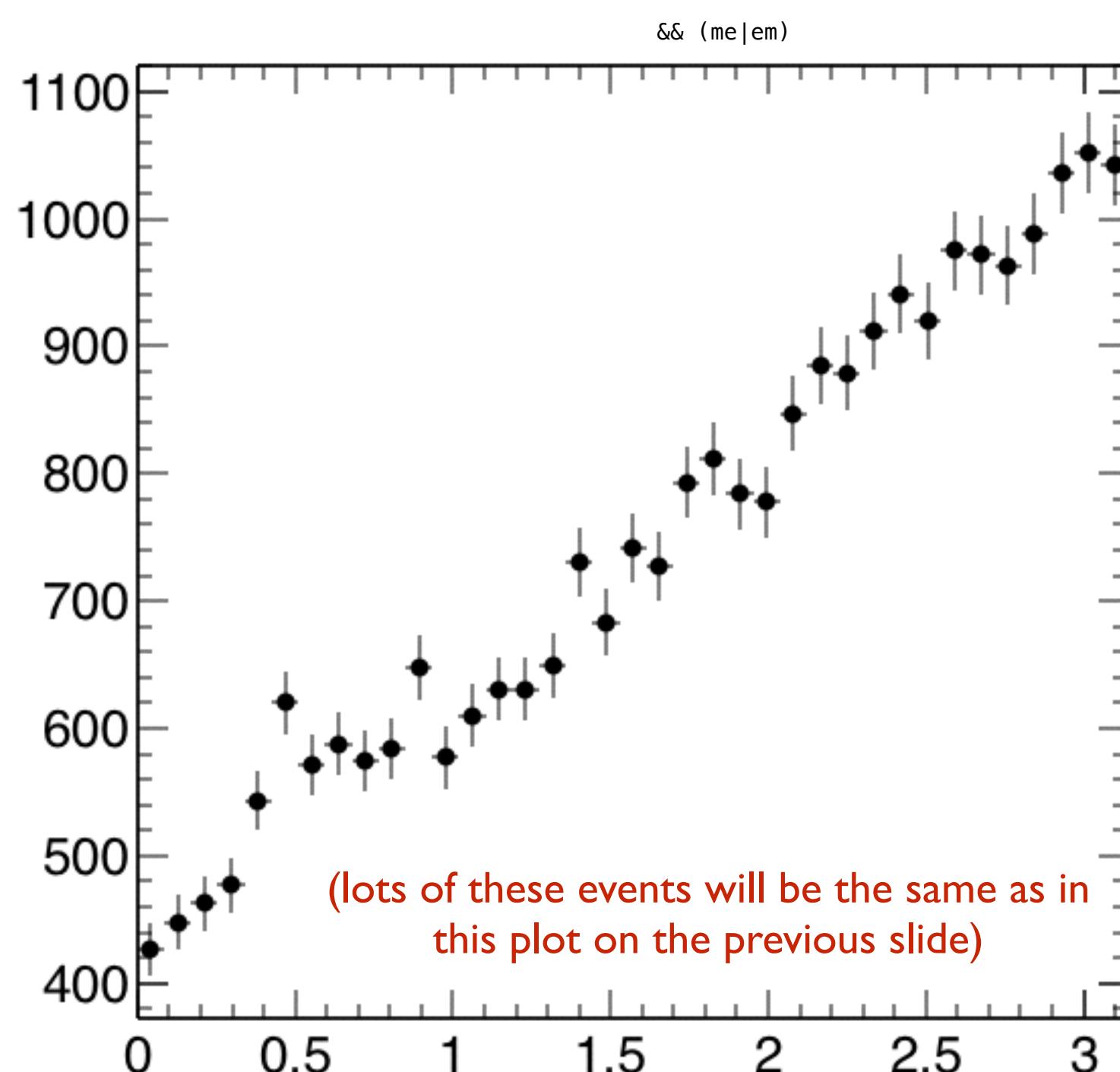
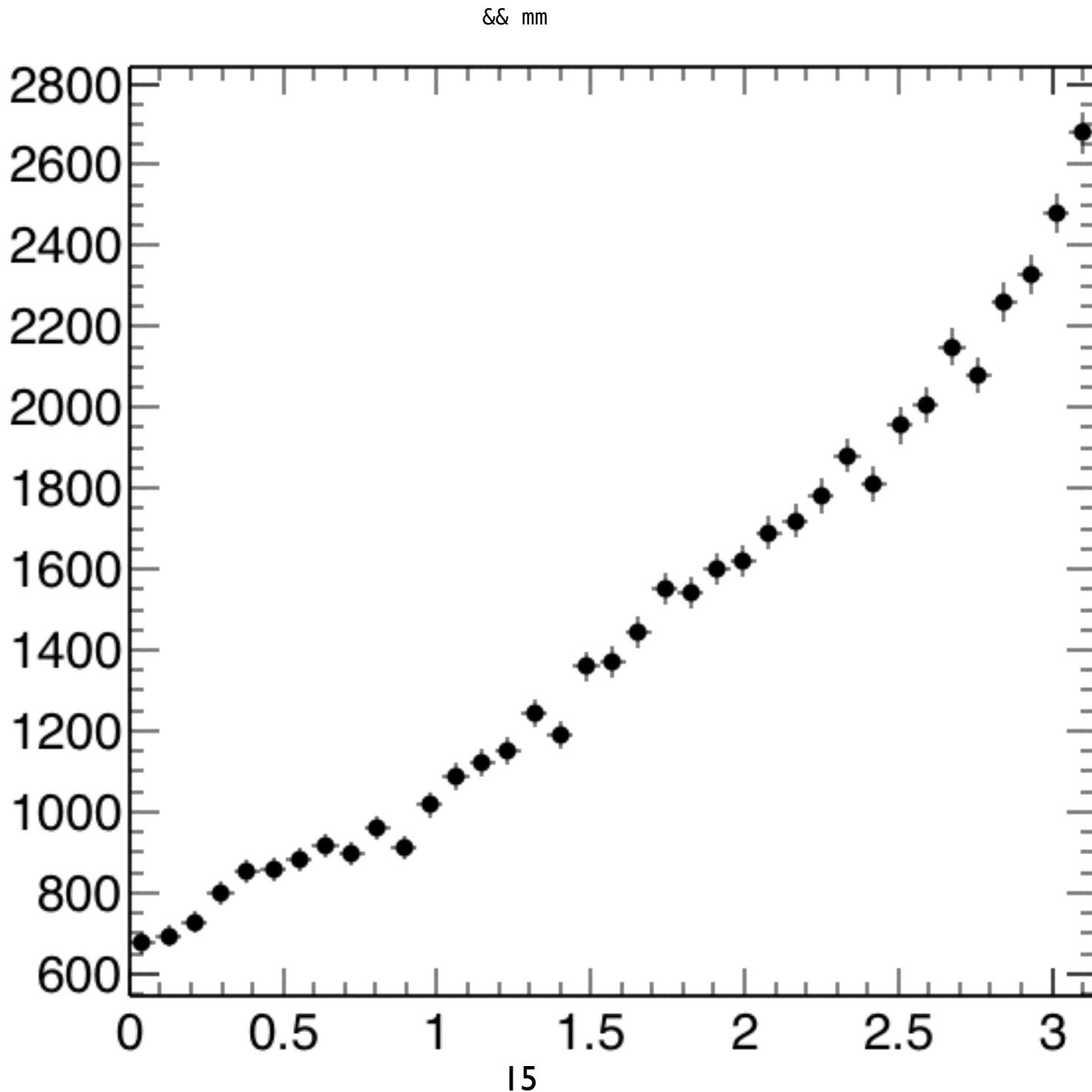
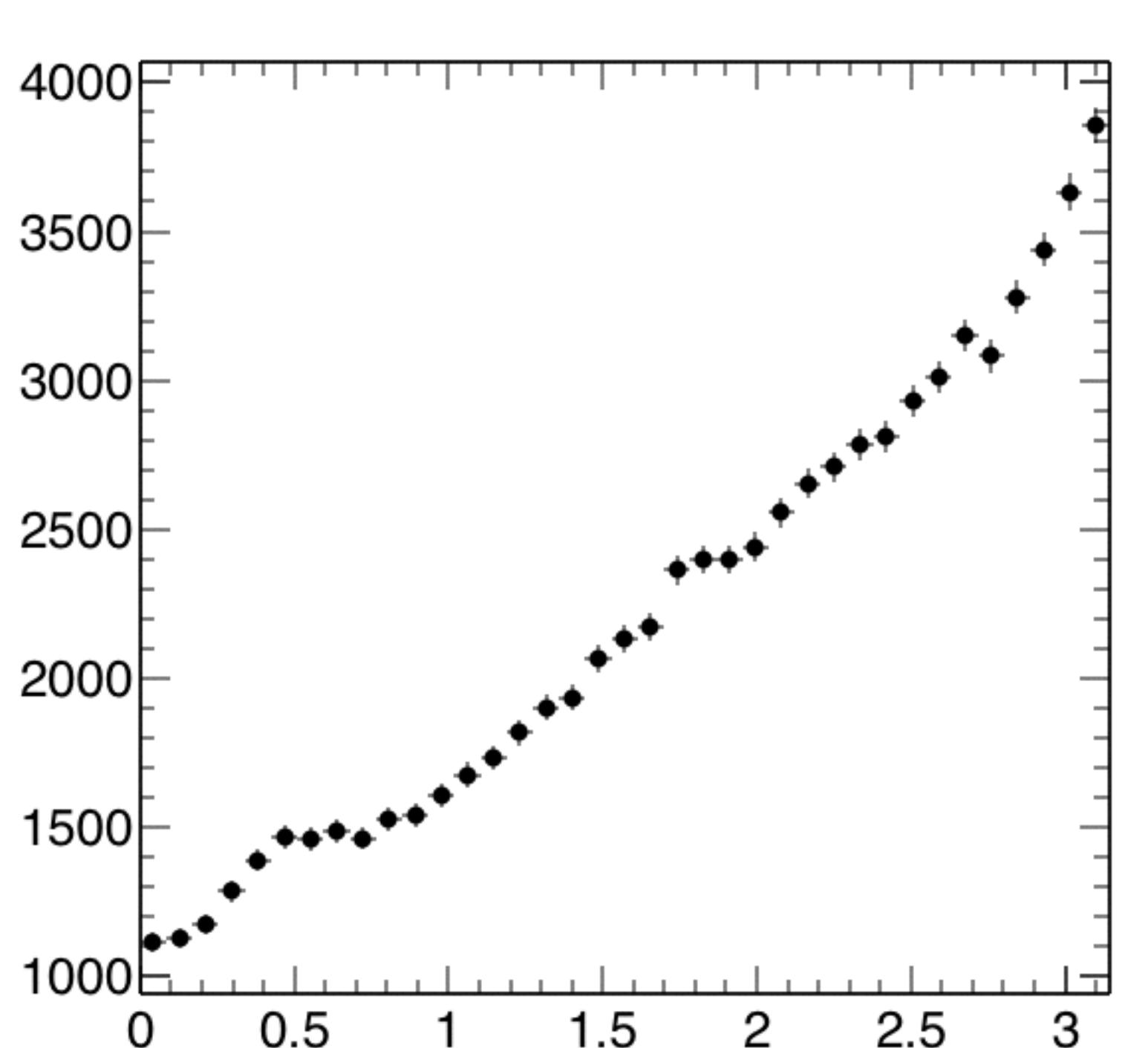
```
t.Draw("abs(2*asin(sin(id1*lep1.Phi())/2./abs(id1)+id2*lep2.Phi())/2./abs(id2)))>>h2(37,0,3.14159265359)", "n good lep==2 && id1*id2<0 && dilmass>12 && lep2.Pt(>20 && nbtagscsvm !=0 && ele27wp80","PE")
```

translation: two good leptons, opposite charge,  $m_{ll} > 12$ , lepton  $p_T > 20$ ,  $\geq 1$  btags, and passed single electron trigger



# Single muon dataset and trigger

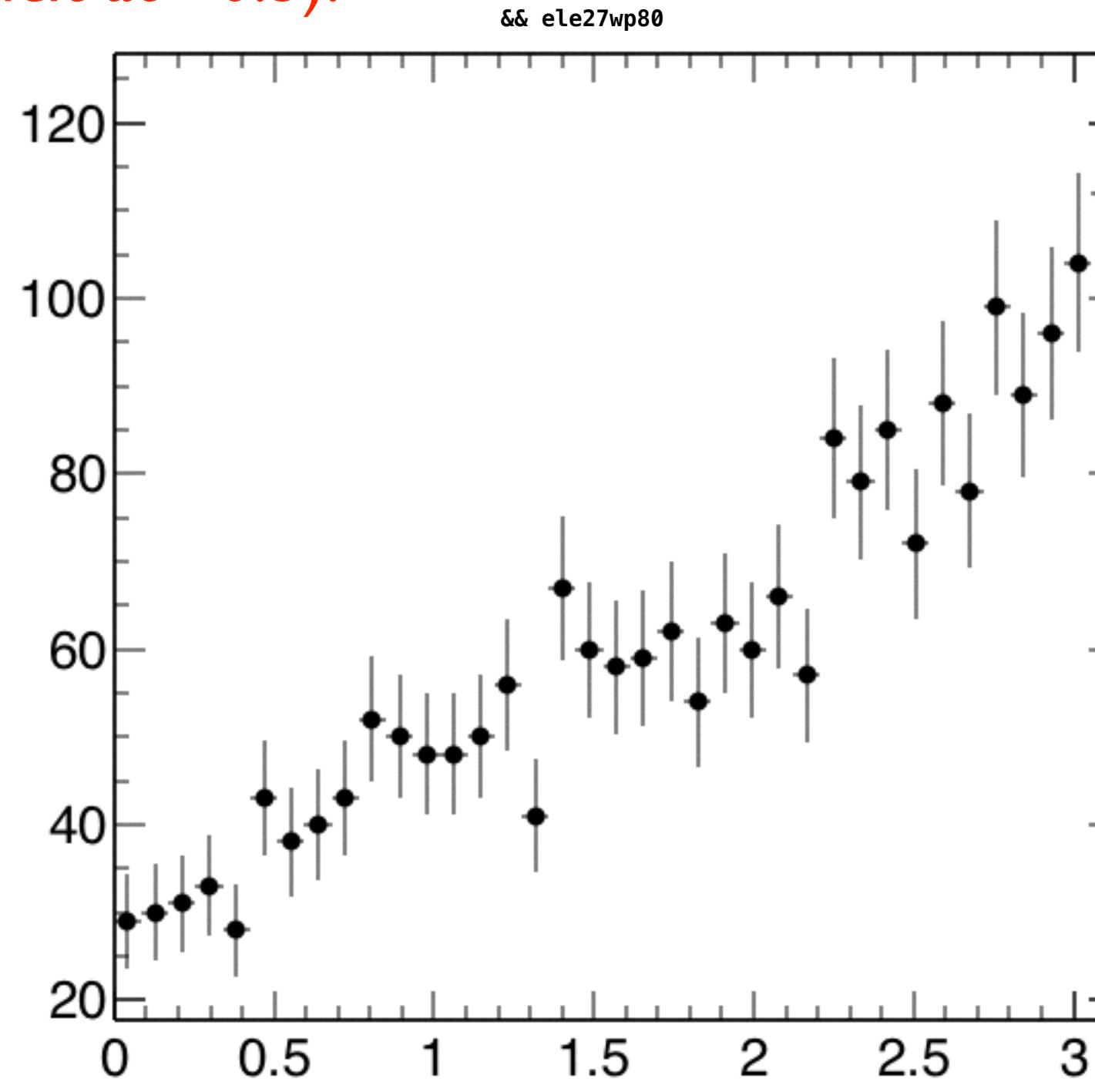
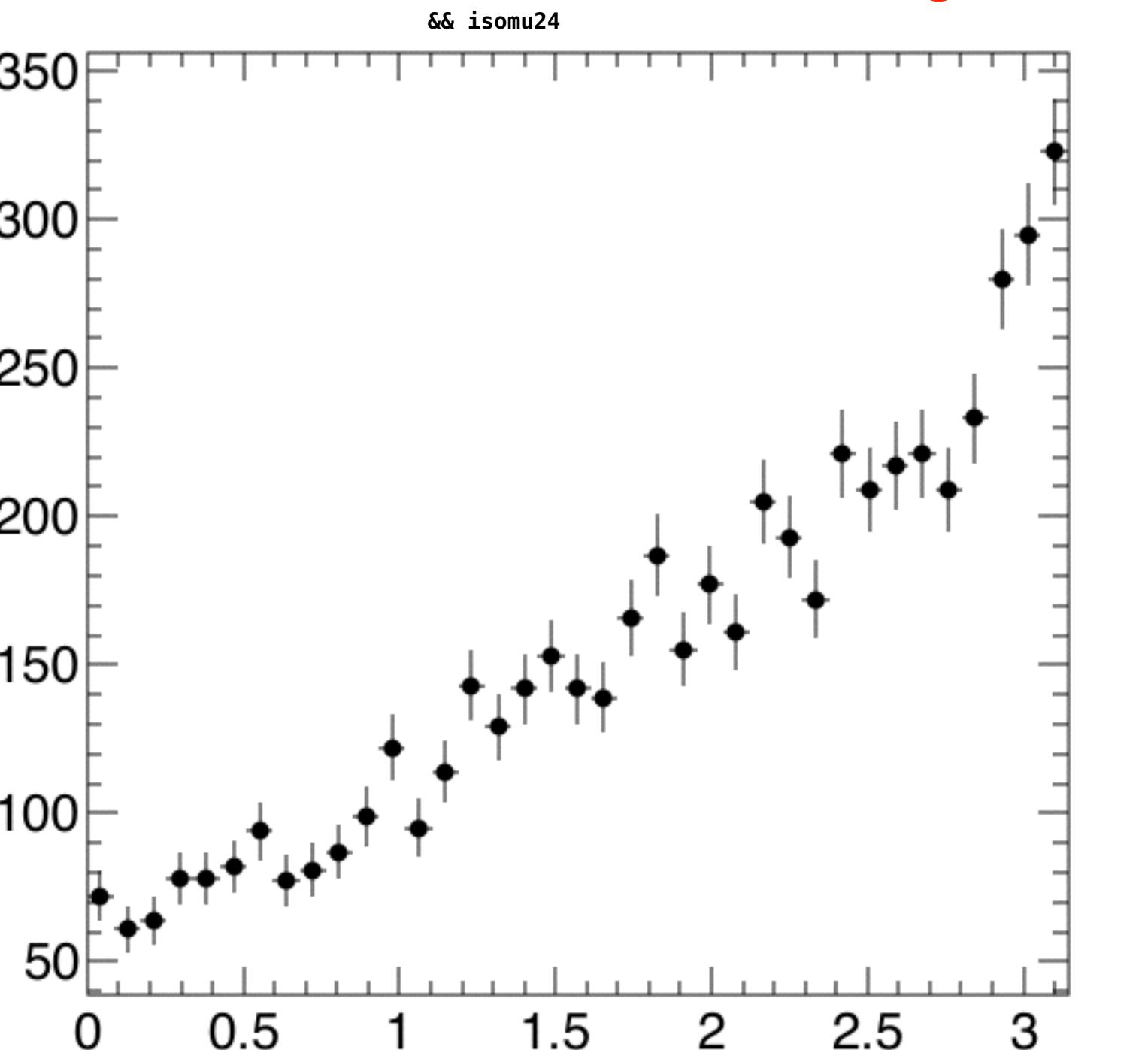
```
t.Draw("abs(2*asin(sin(id1*lep1.Phi())/2./abs(id1)+id2*lep2.Phi())/2./abs(id2)))>>h2(37,0,3.14159265359)", "n good lep==2 && id1*id2<0 && dilmass>12 && lep2.Pt(>20 && nbtagscsvm !=0 && isomu24","PE")
```



# Single lepton trigger, 2 good leptons, but not dilepton trigger

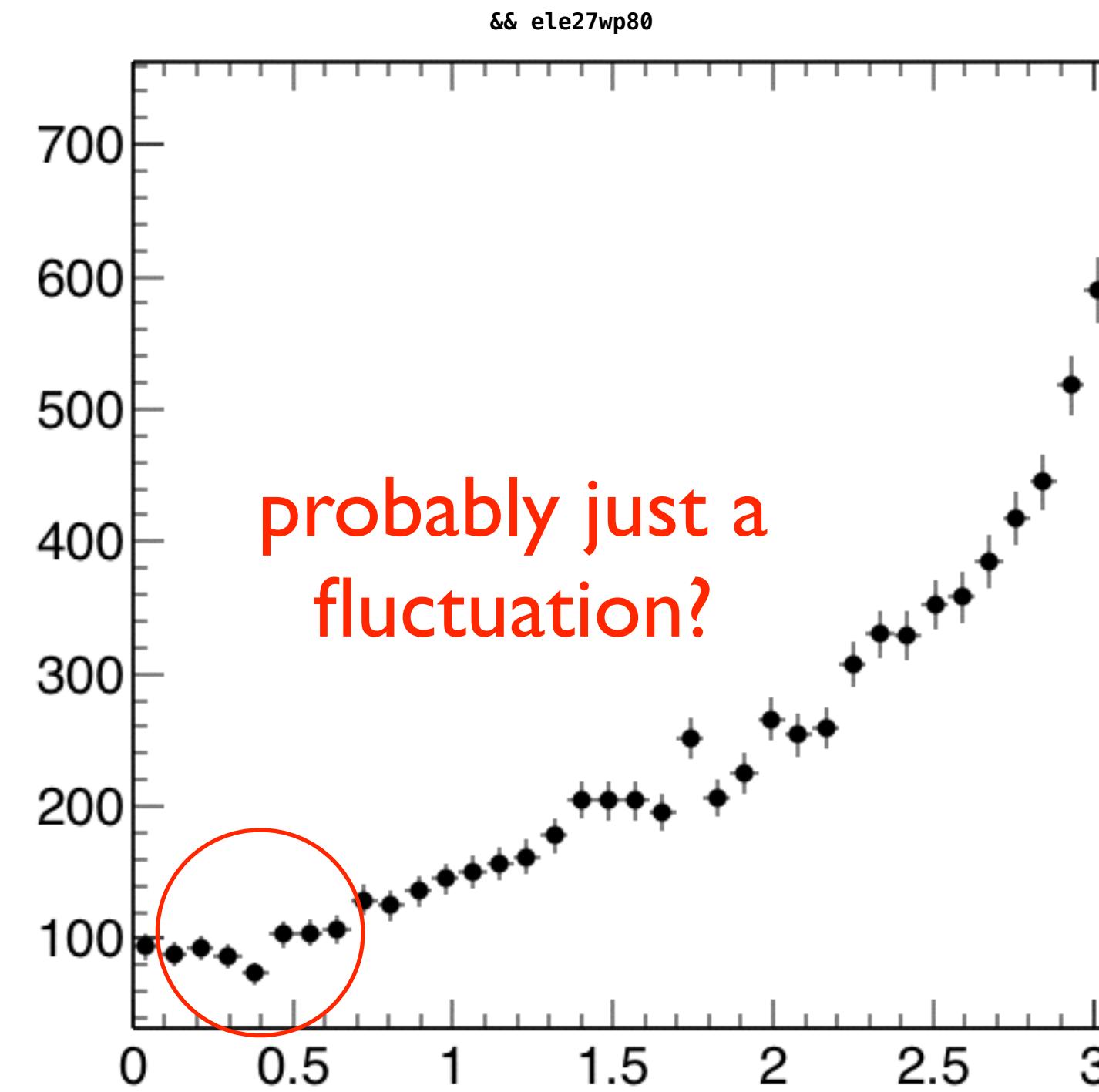
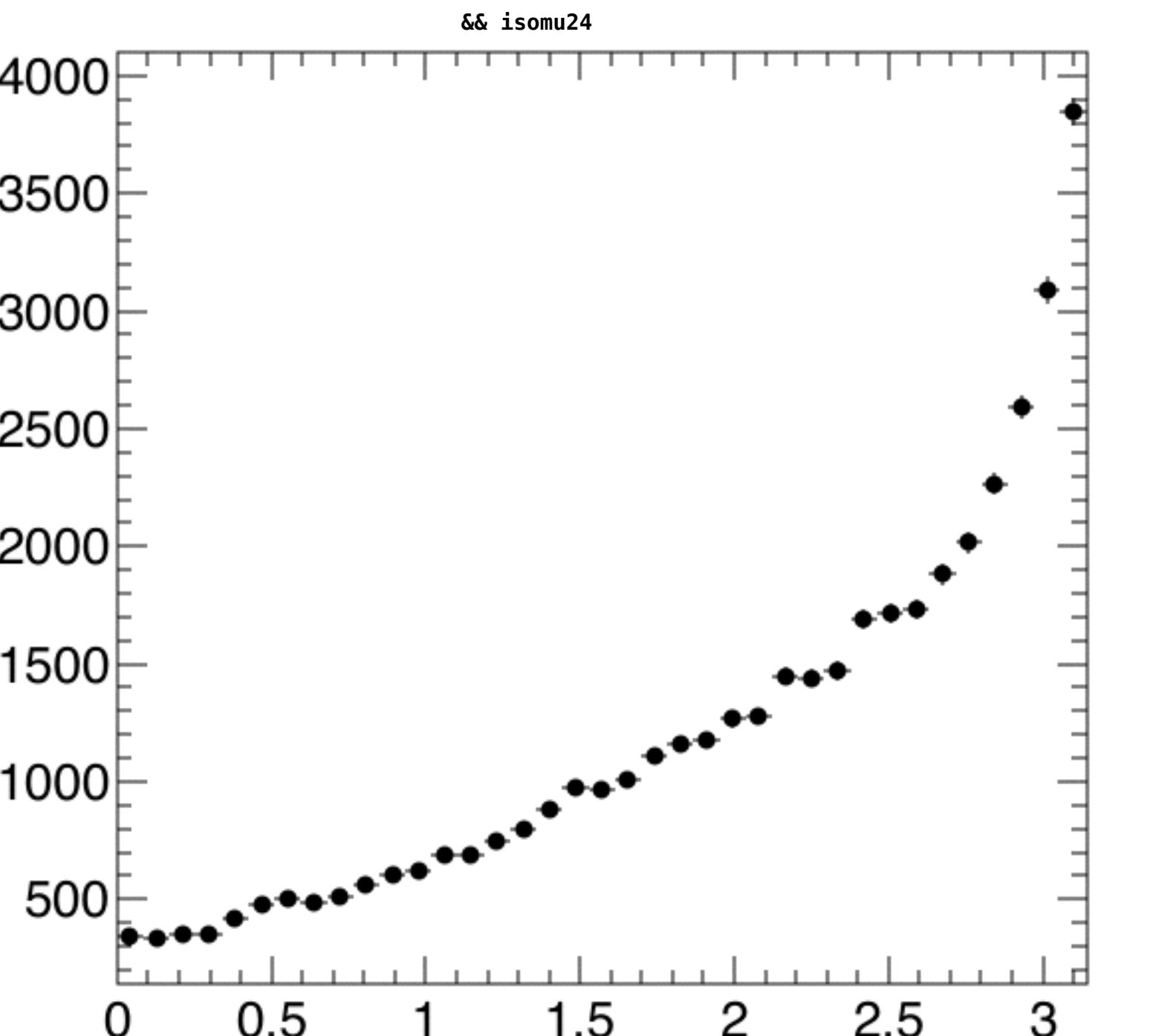
```
t.Draw("acos(cos(lep1.Phi())-lep2.Phi()))>>h2(37,0,3.14159265359)", "ngoodlep==2 && id1*id2<0 && dilmass>20 && lep2.Pt()>20 && !(me|em|mm|ee) && nbtagscsvm !=0","PE")
```

These plots show the events that only failed the dilepton trigger due to inefficiency (but limited statistics).  
Nothing stands out (e.g. no significant deficit at  $\sim 0.5$ ).



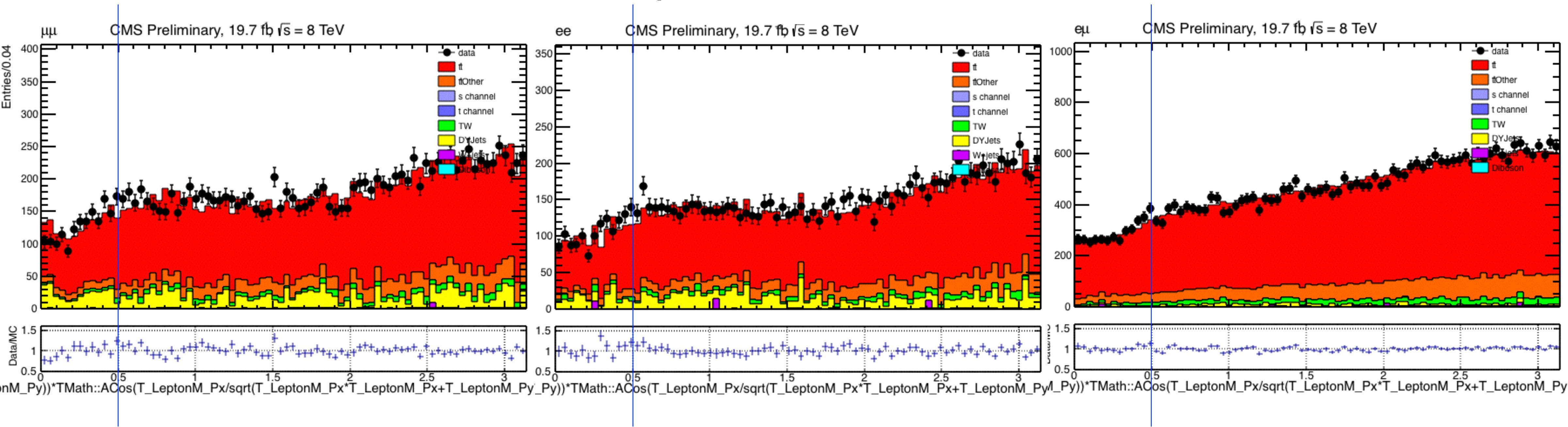
# Single lepton trigger, 2 good leptons, but not dilepton trigger, no btag

```
t.Draw("acos(cos(lep1.Phi())-lep2.Phi()))>>h2(37,0,3.14159265359)", "ngoodlep==2 && id1*id2<0 && dilmass>20 && lep2.Pt()>20 && !(me|em|mm|ee)","PE")
```

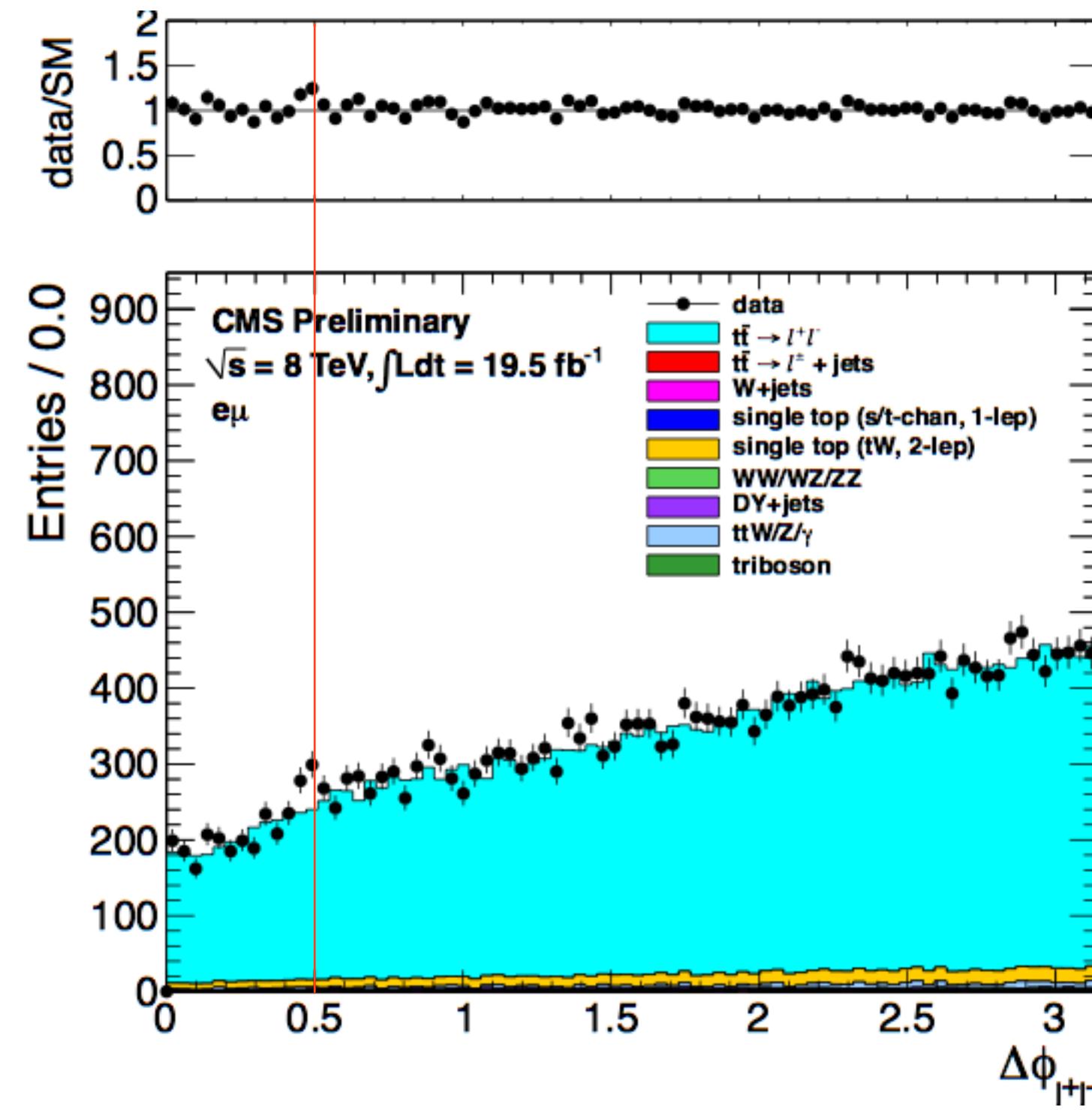
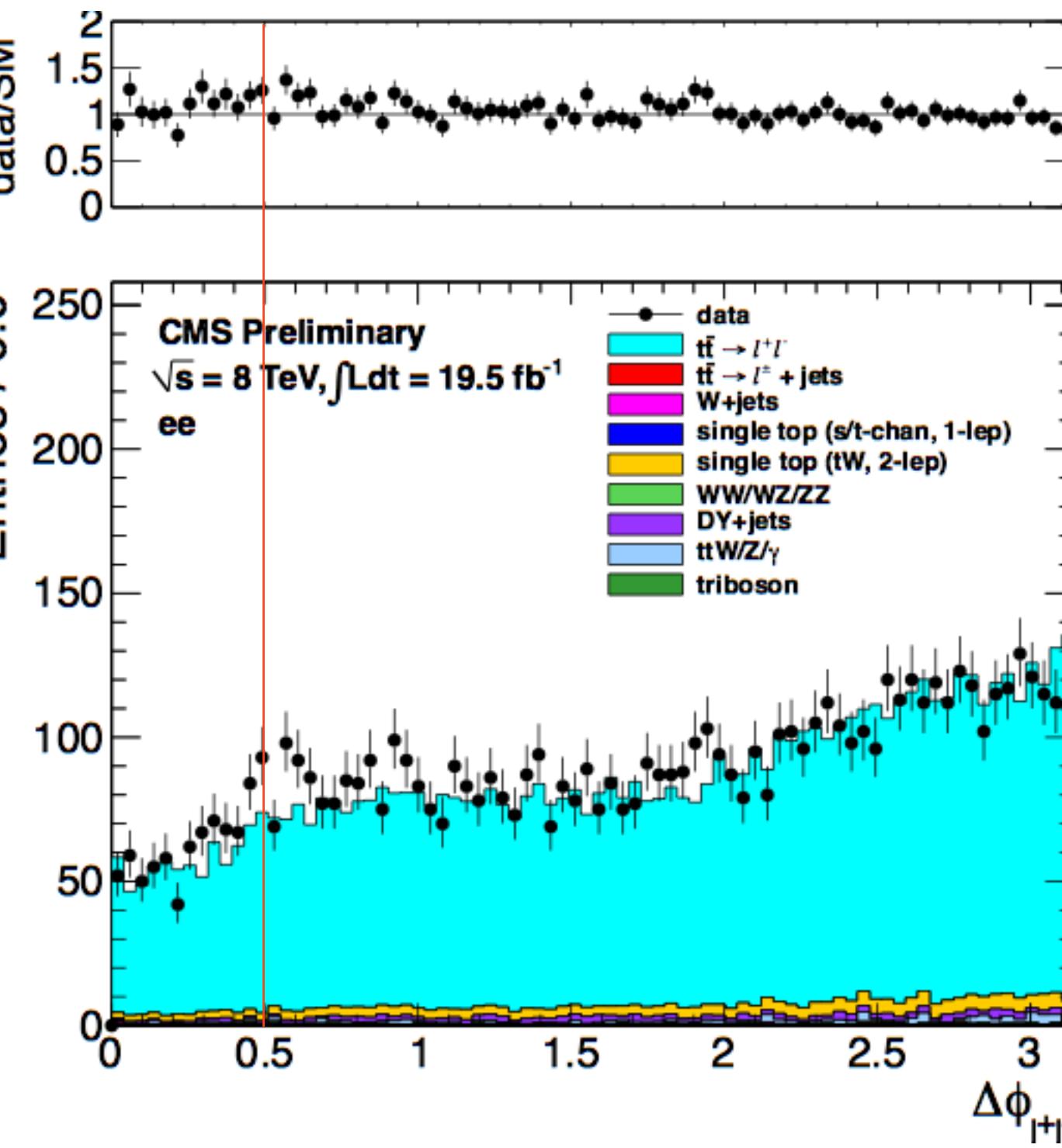
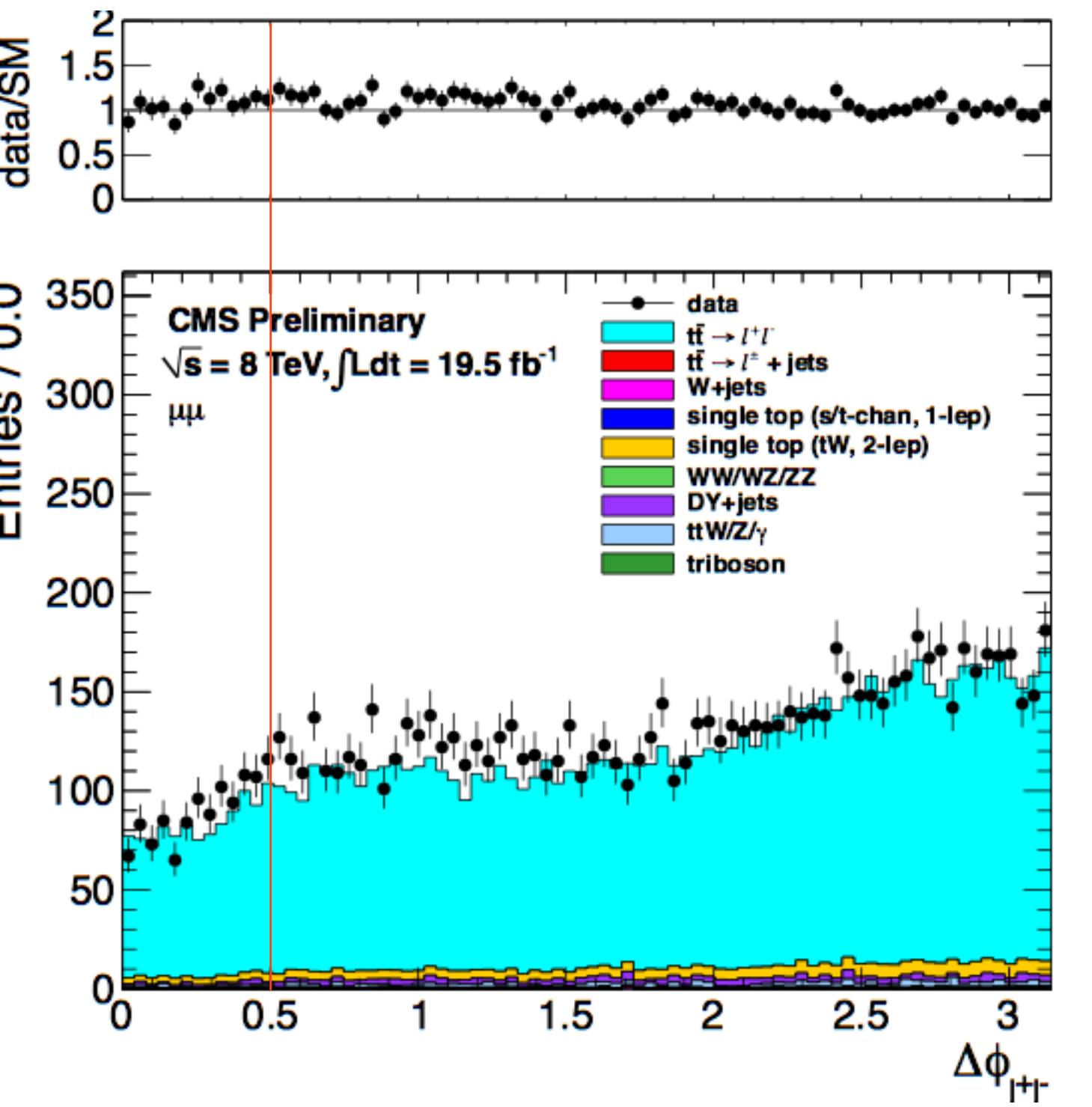


# Plots from Mohsen, who is working on a dilepton W Helicity measurement in the properties group, with a similar (but looser) event selection

- confirms it isn't a bug in our code, or anything to do with not using the latest ReReco or “recommended” electron and muon objects



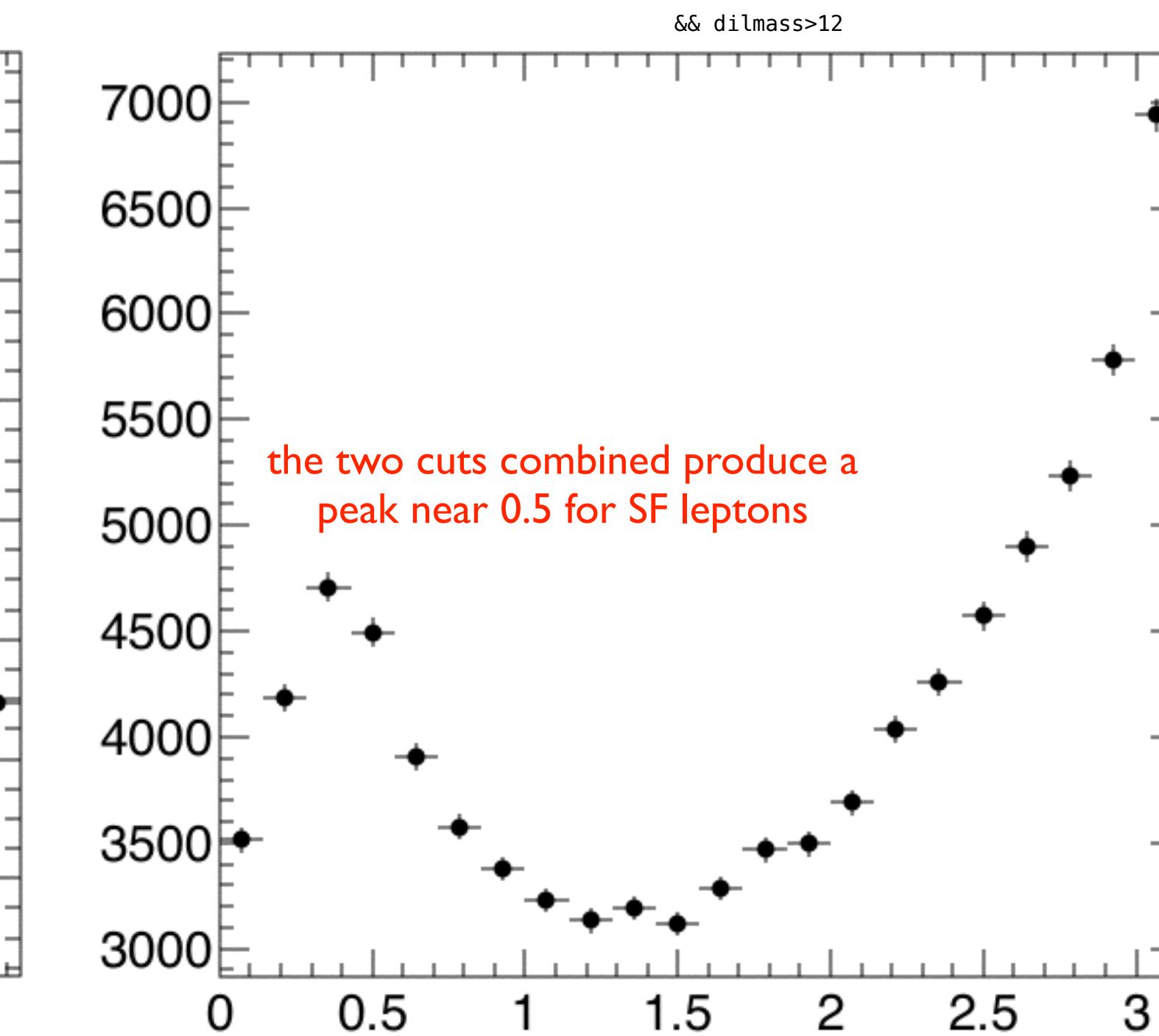
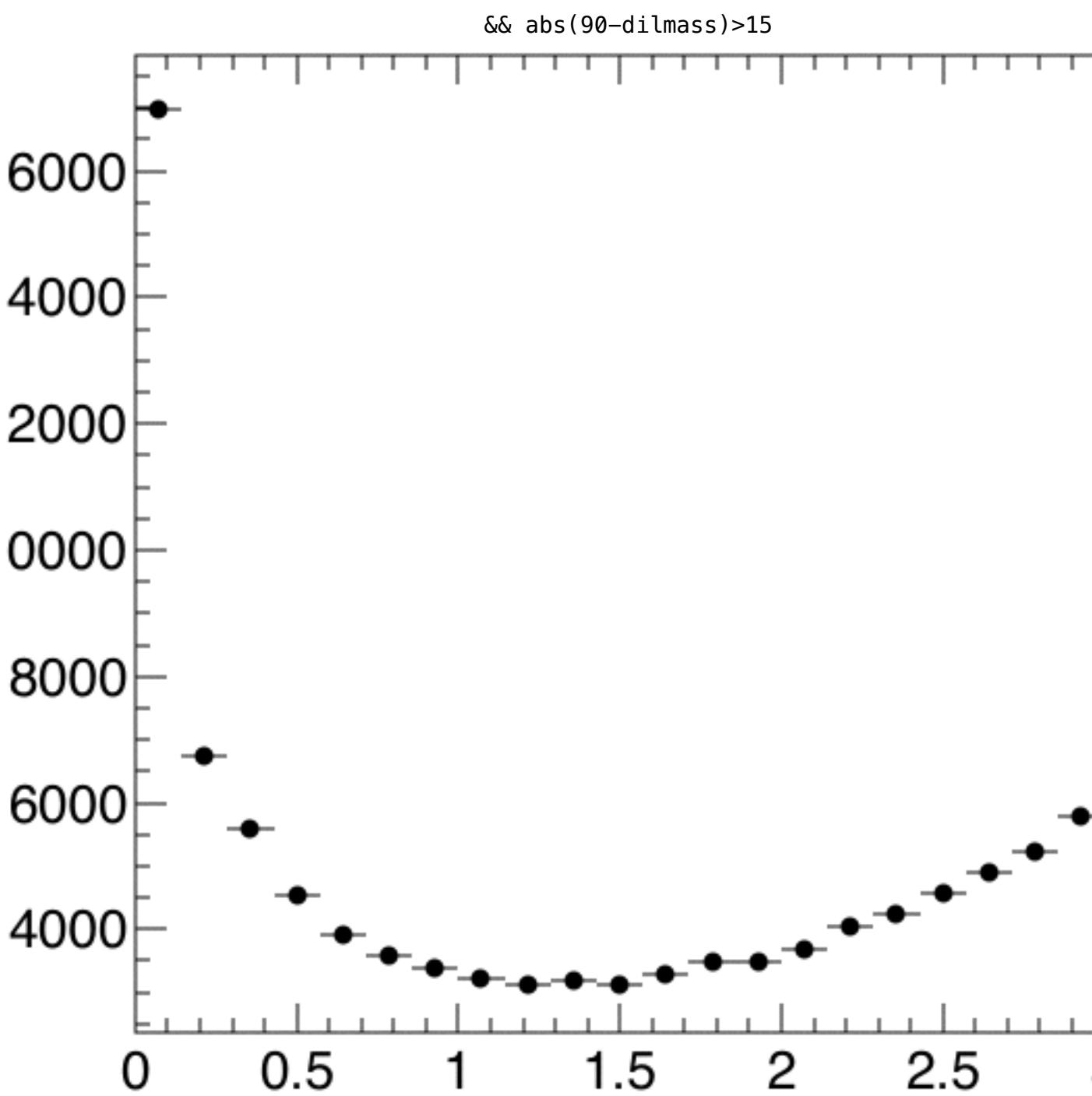
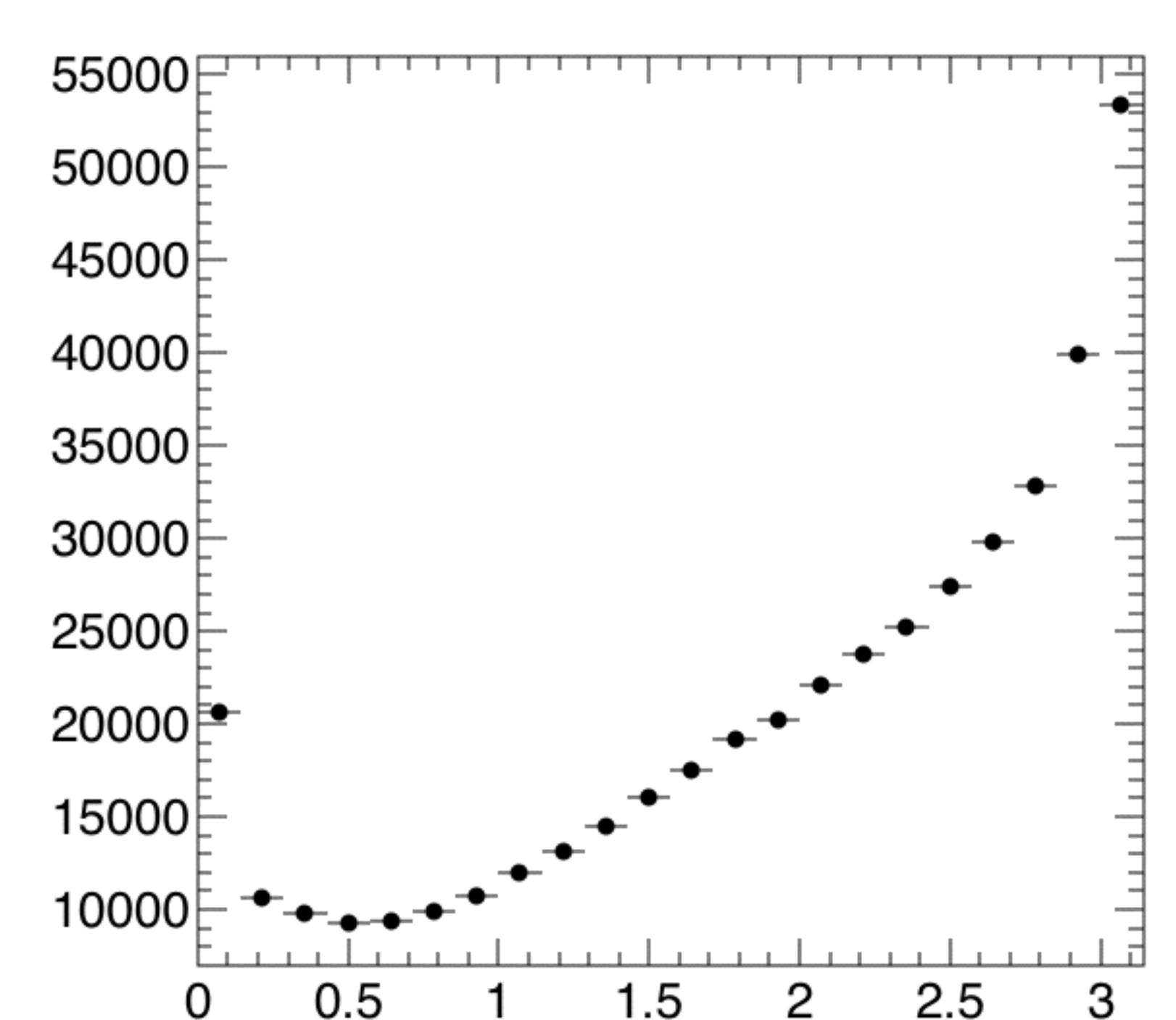
# Our plots again for comparison



# $\Delta\phi$ sculpted by low mass resonance and Z vetos?

This could explain some of the shape in the ee and  $\mu\mu$  channels, but of course not  $e\mu$

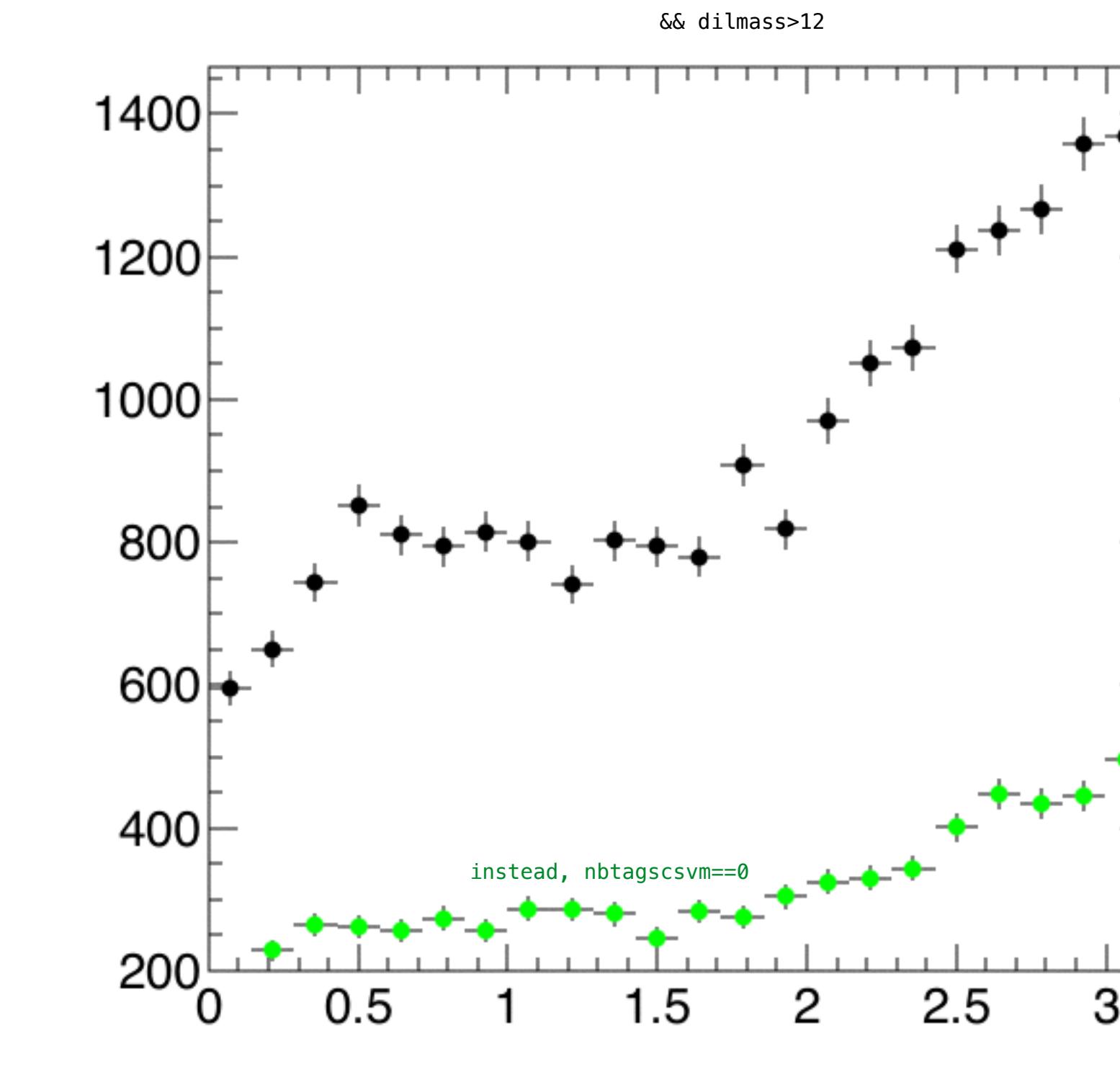
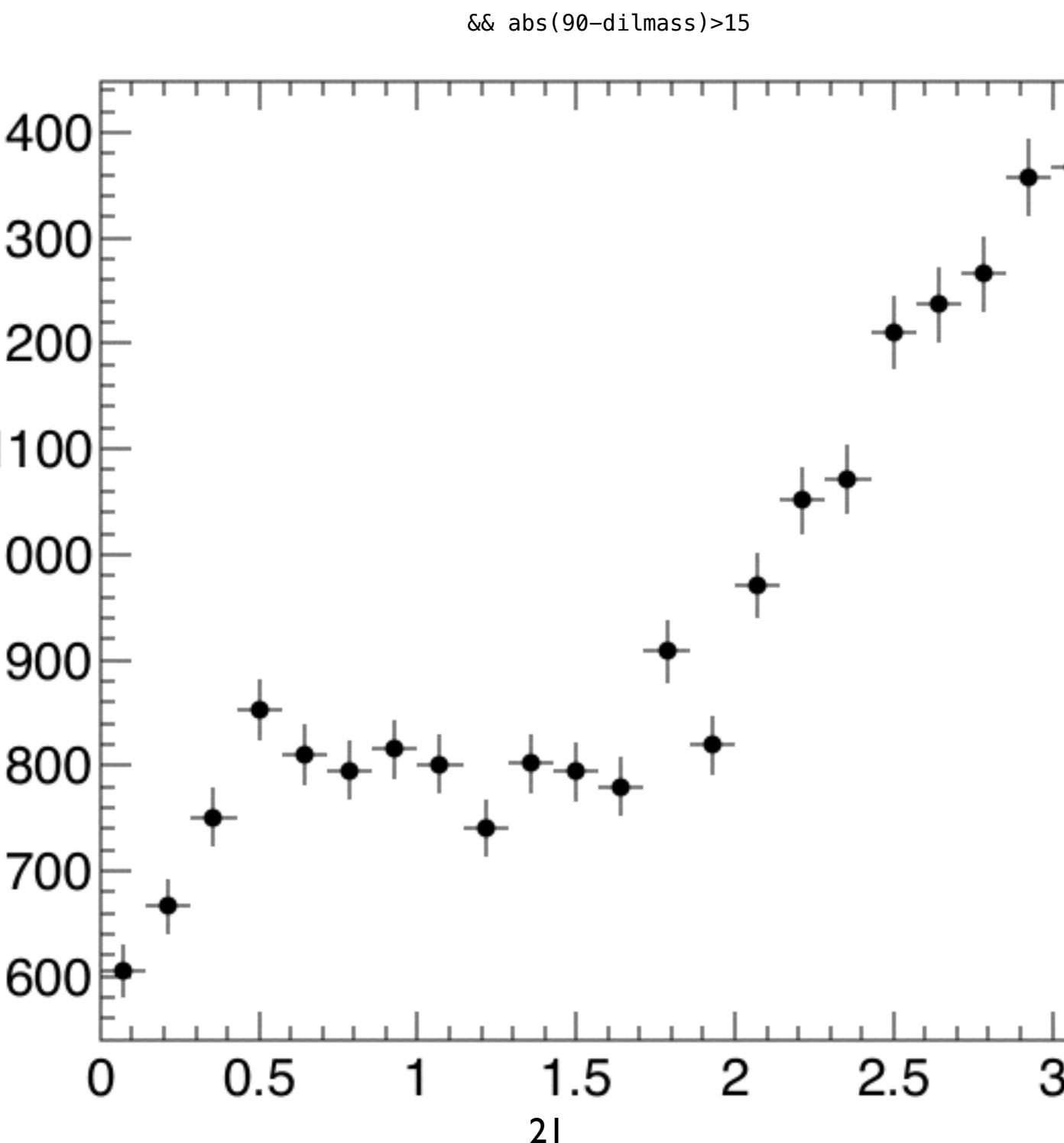
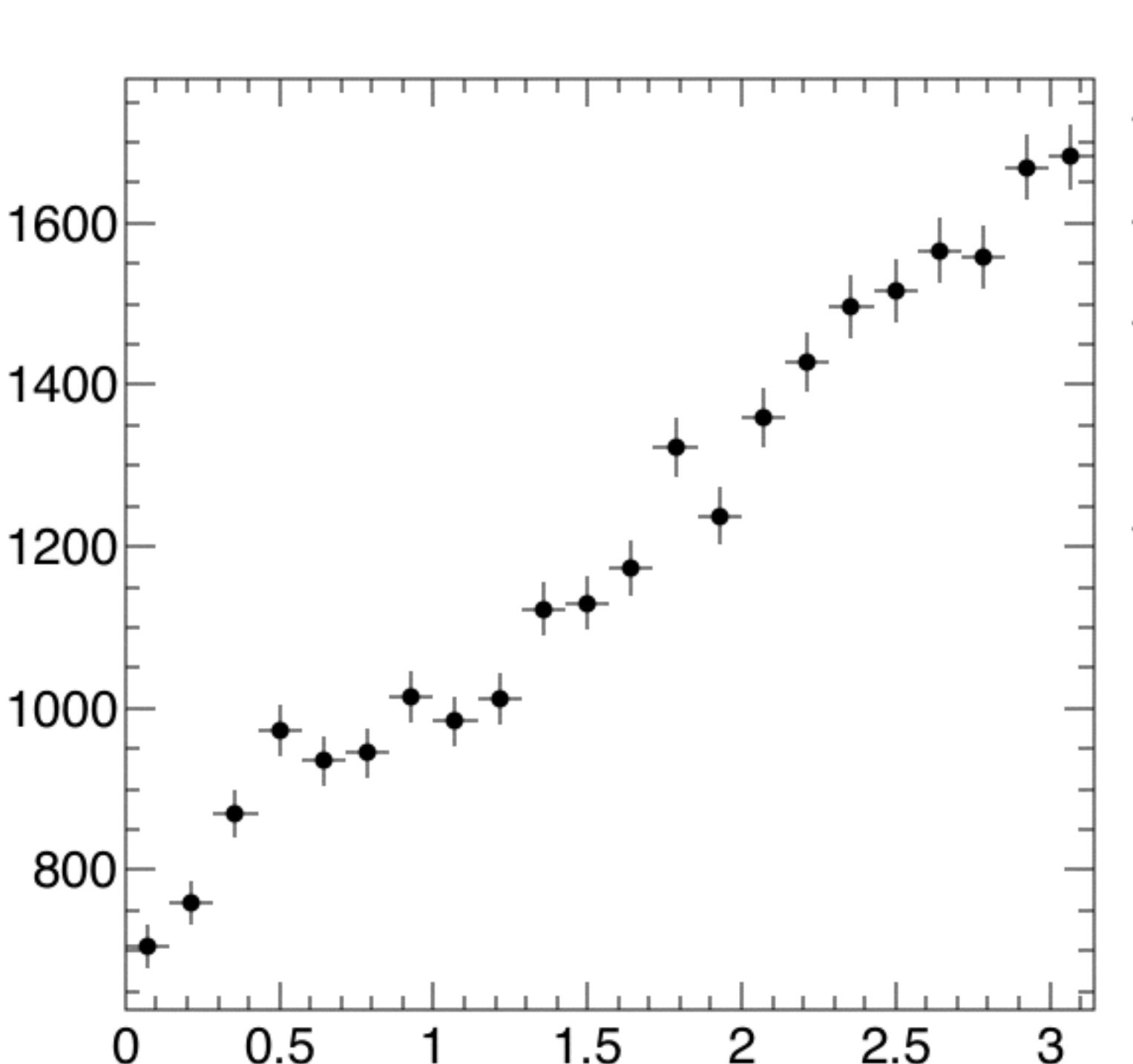
```
t.Draw("acos(cos(lep1.Phi())-lep2.Phi()))>>h2(22,0,3.14159265359)", "ngoodlep==2 && id1*id2<0 && lep2.Pt()>20 && isomu24","PE")
```



# $\Delta\phi$ sculpted by low mass resonance and Z vetos?

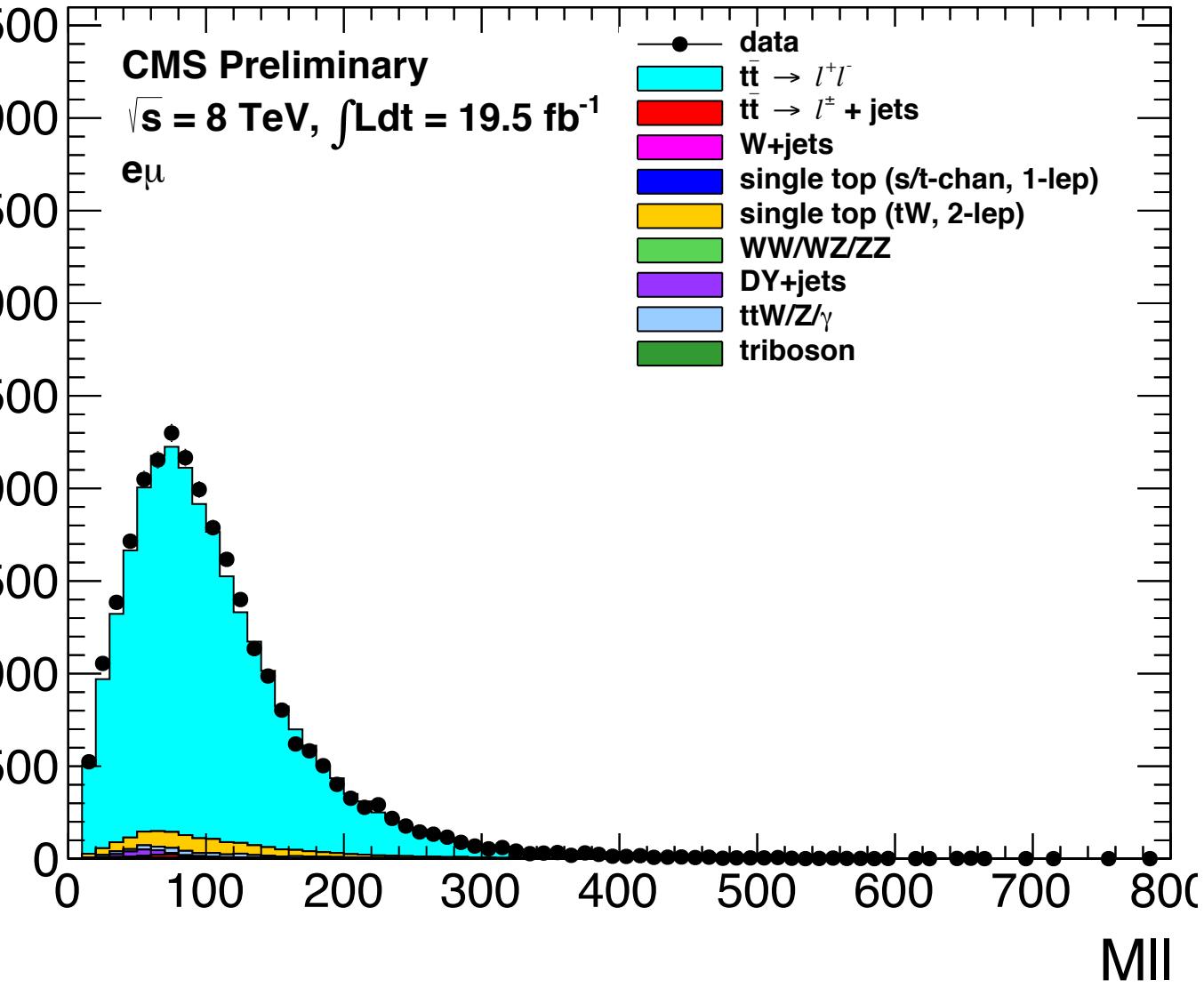
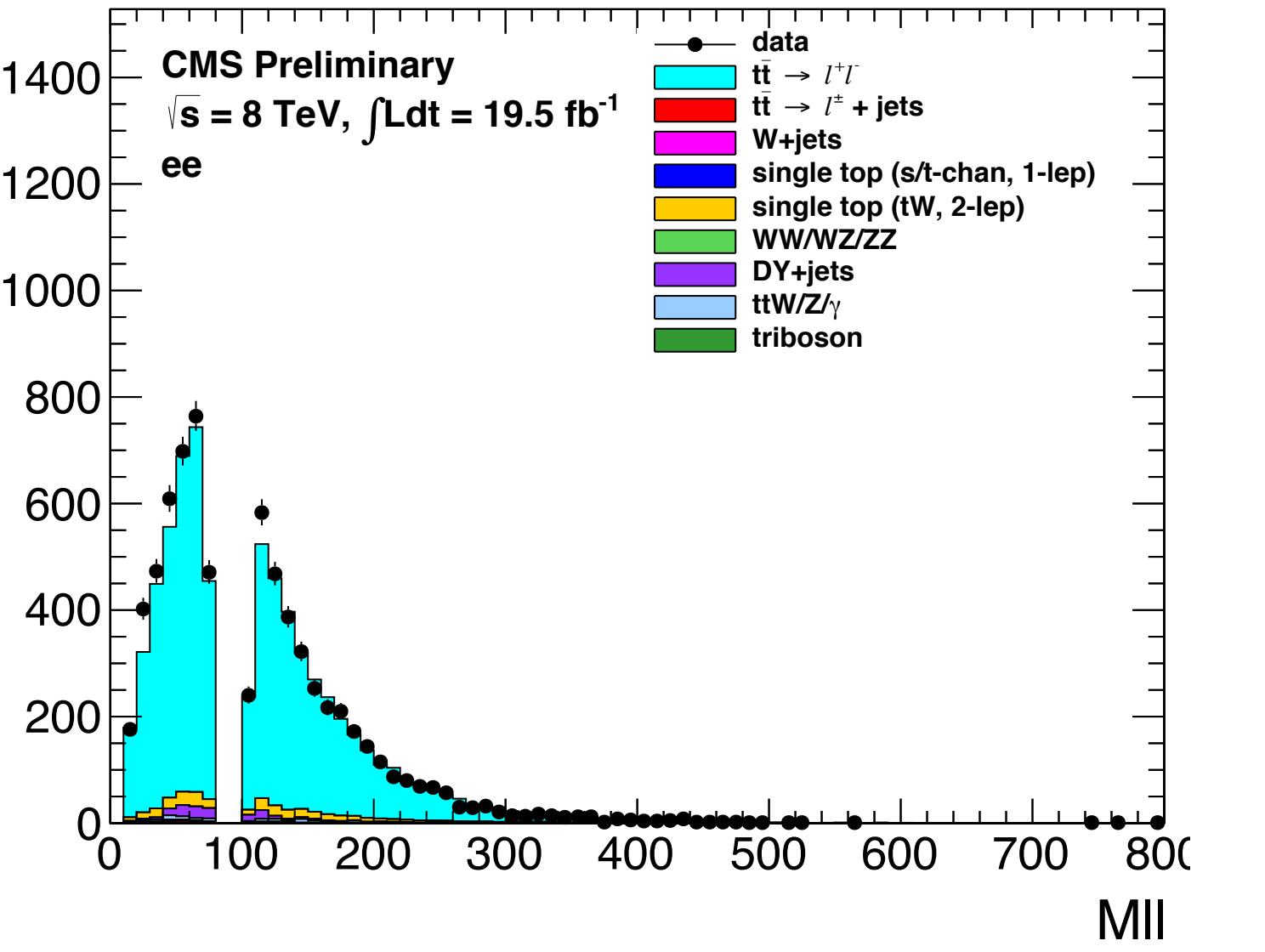
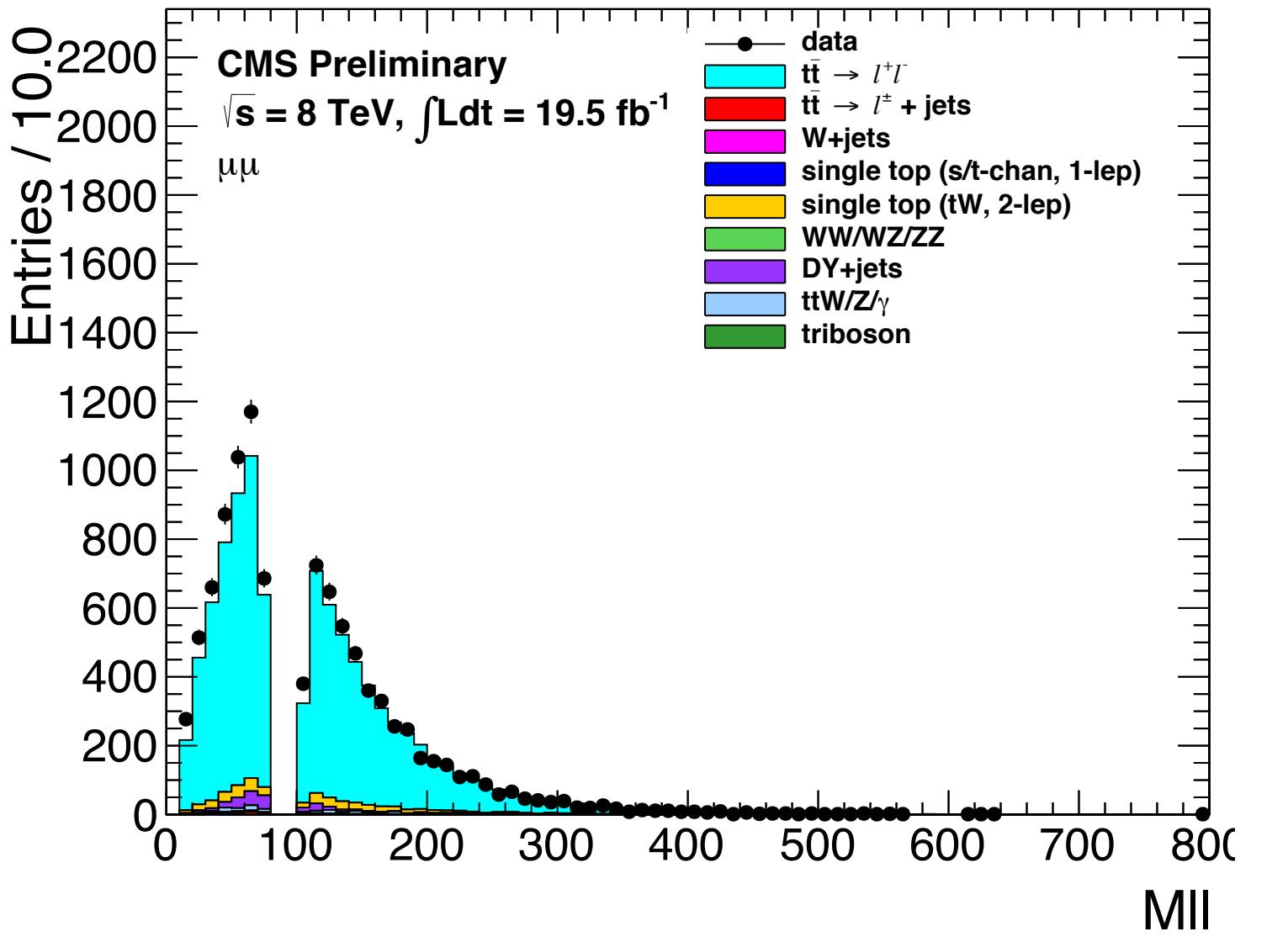
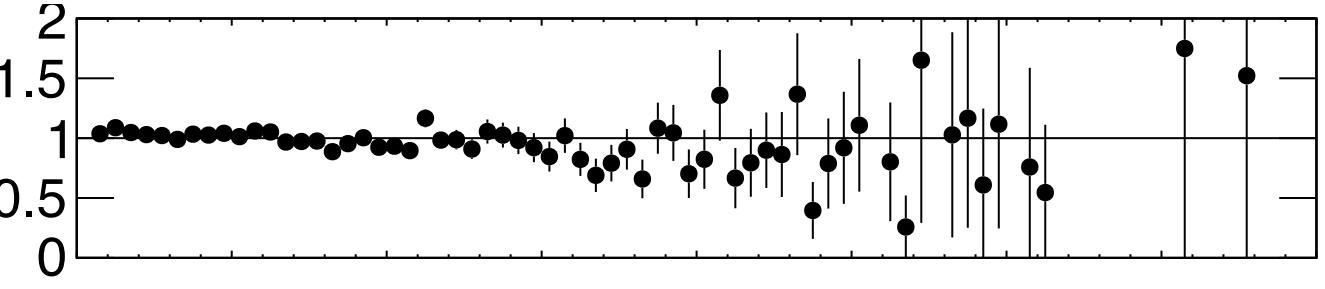
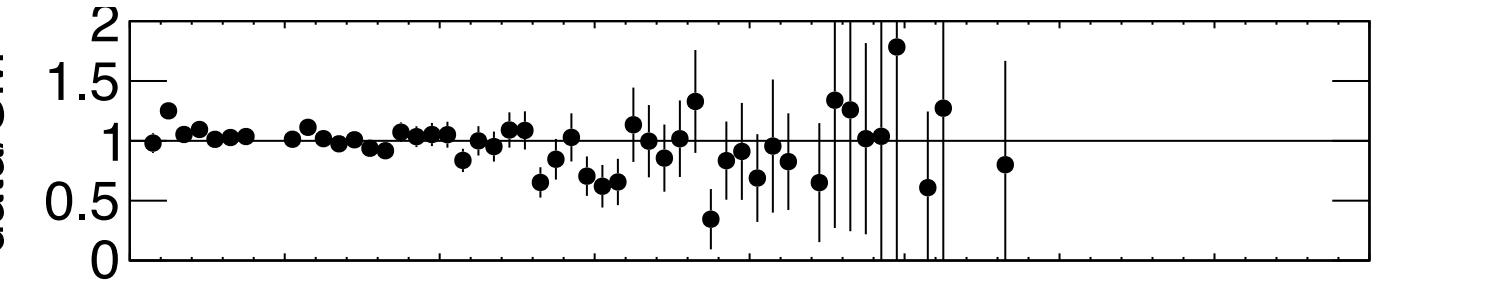
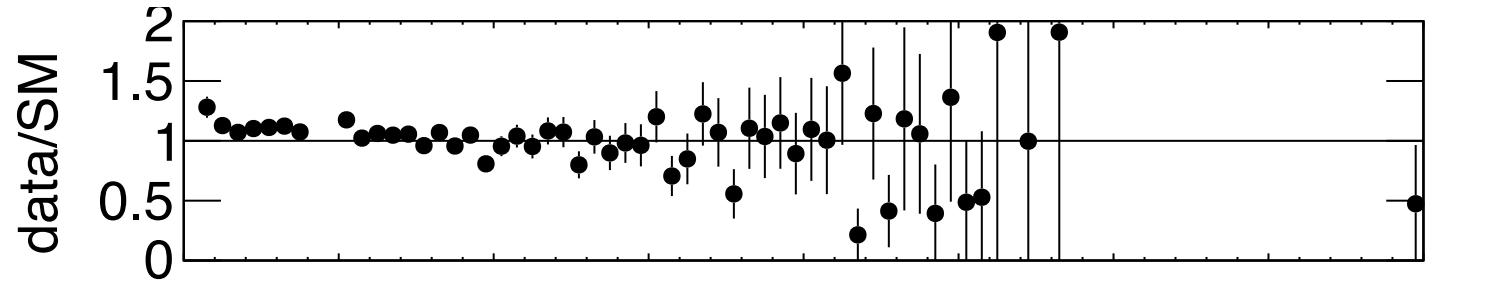
... but it can't explain the bump in  $e\mu$  events

```
t.Draw("acos(cos(lep1.Phi())-lep2.Phi()))>>h2(22,0,3.14159265359)", "ngoodlep==2 && id1*id2<0 && lep2.Pt(>20 && isomu24 && (me|em) && nbtagscsvm>0 && abs(id1)!=abs(id2)","PE")
```



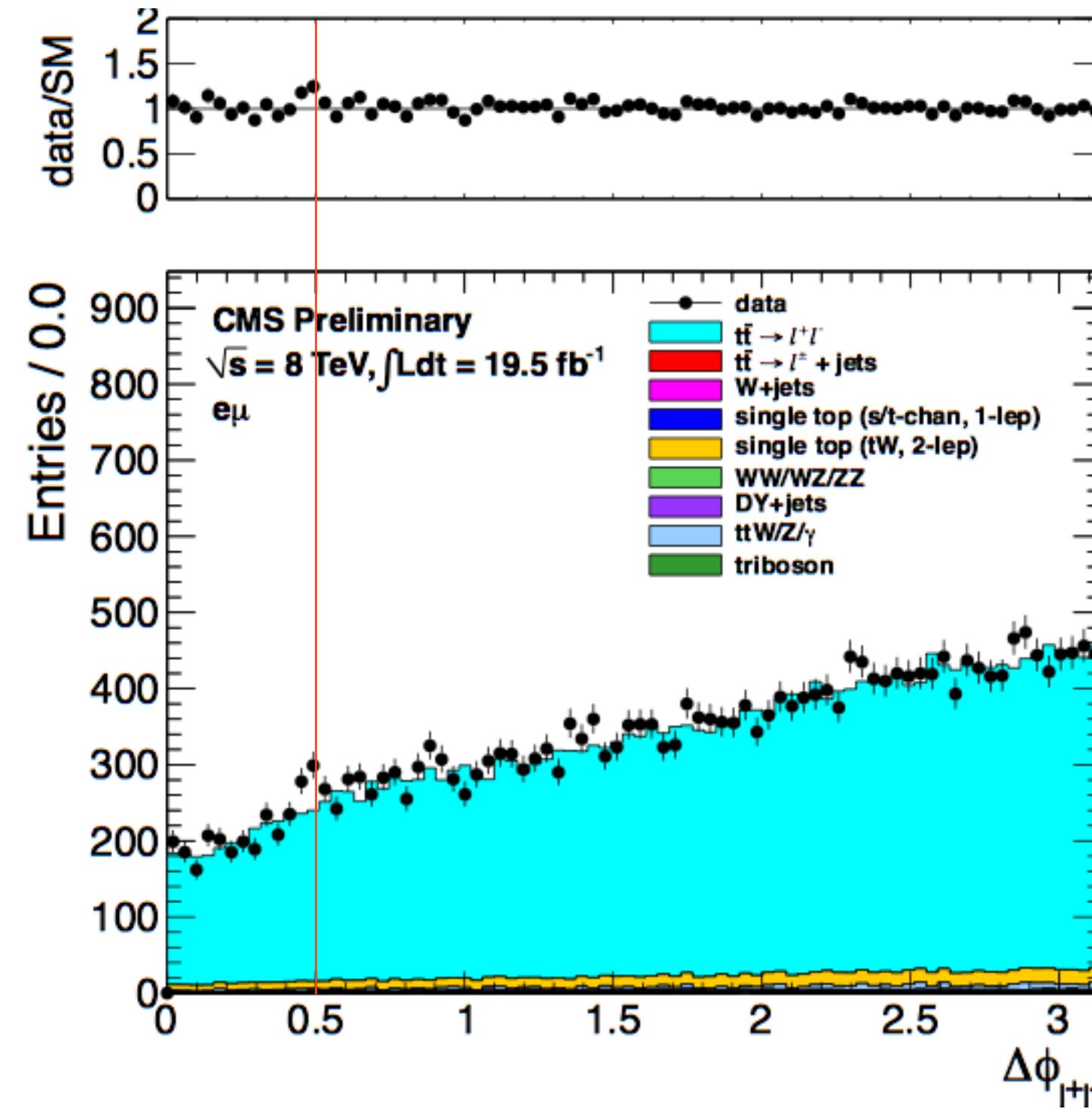
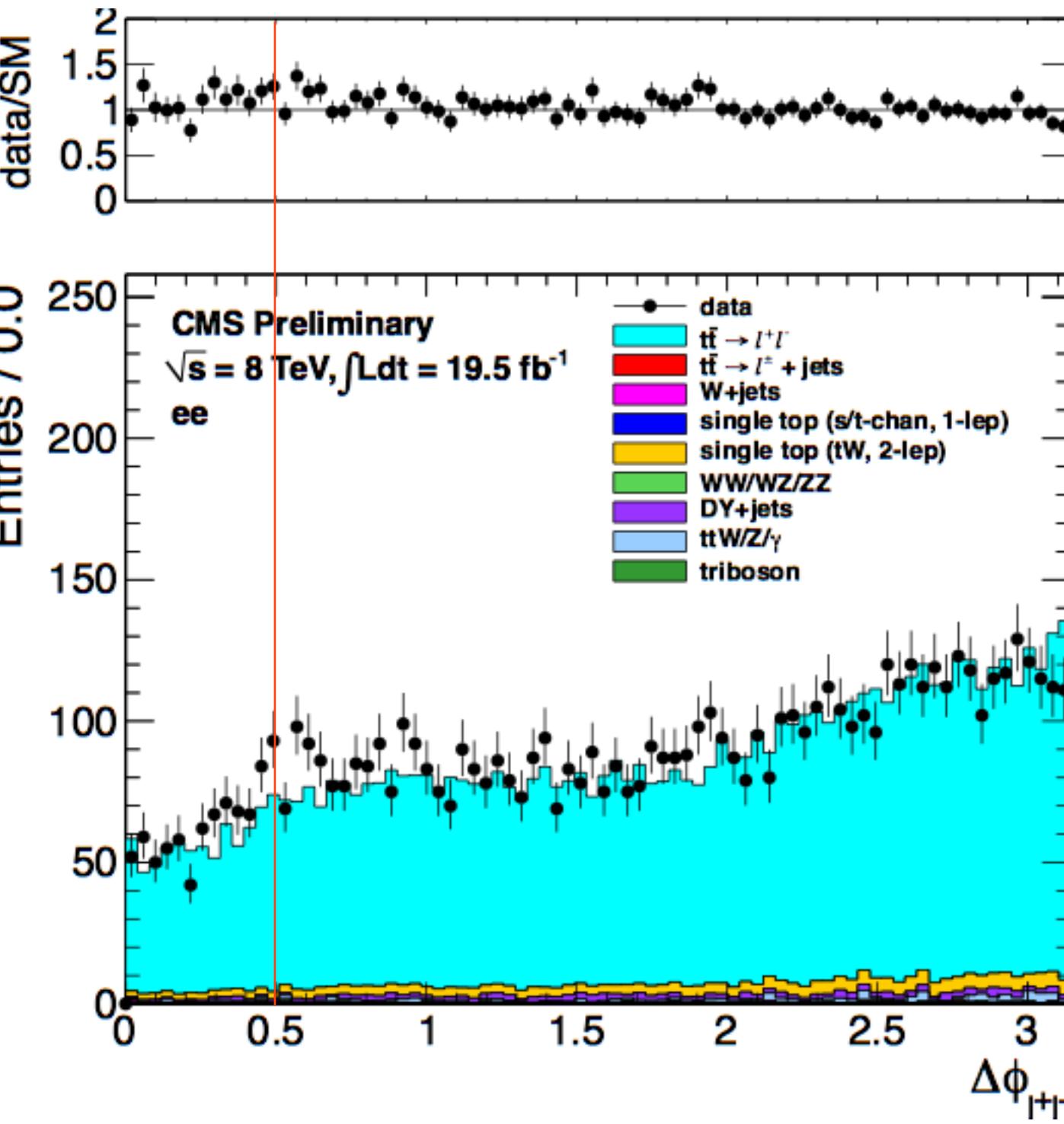
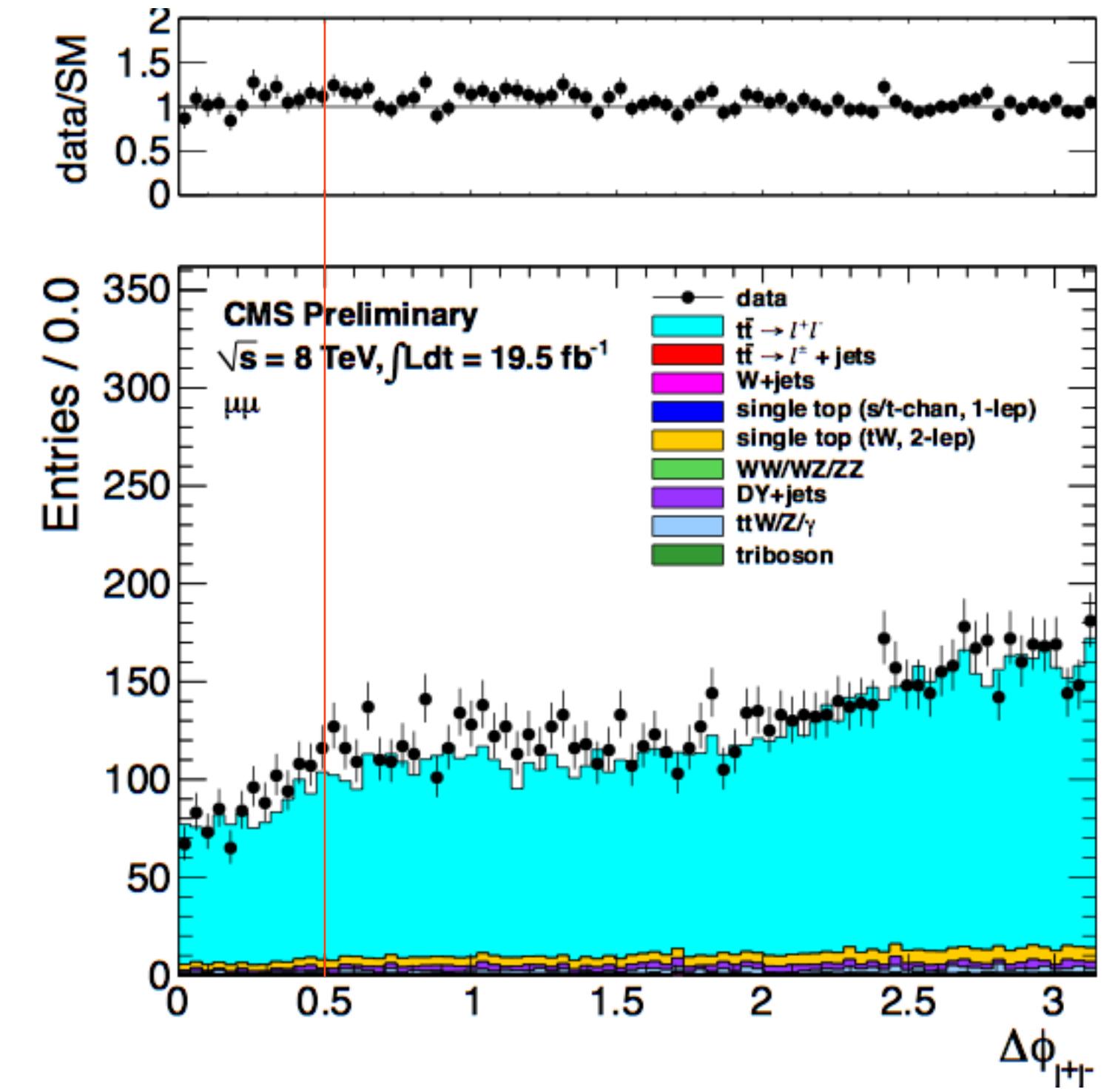
instead,   
 nbtagscsvm==0

# $M_{\parallel}$ mismodelling in SF channels (or missing samples)

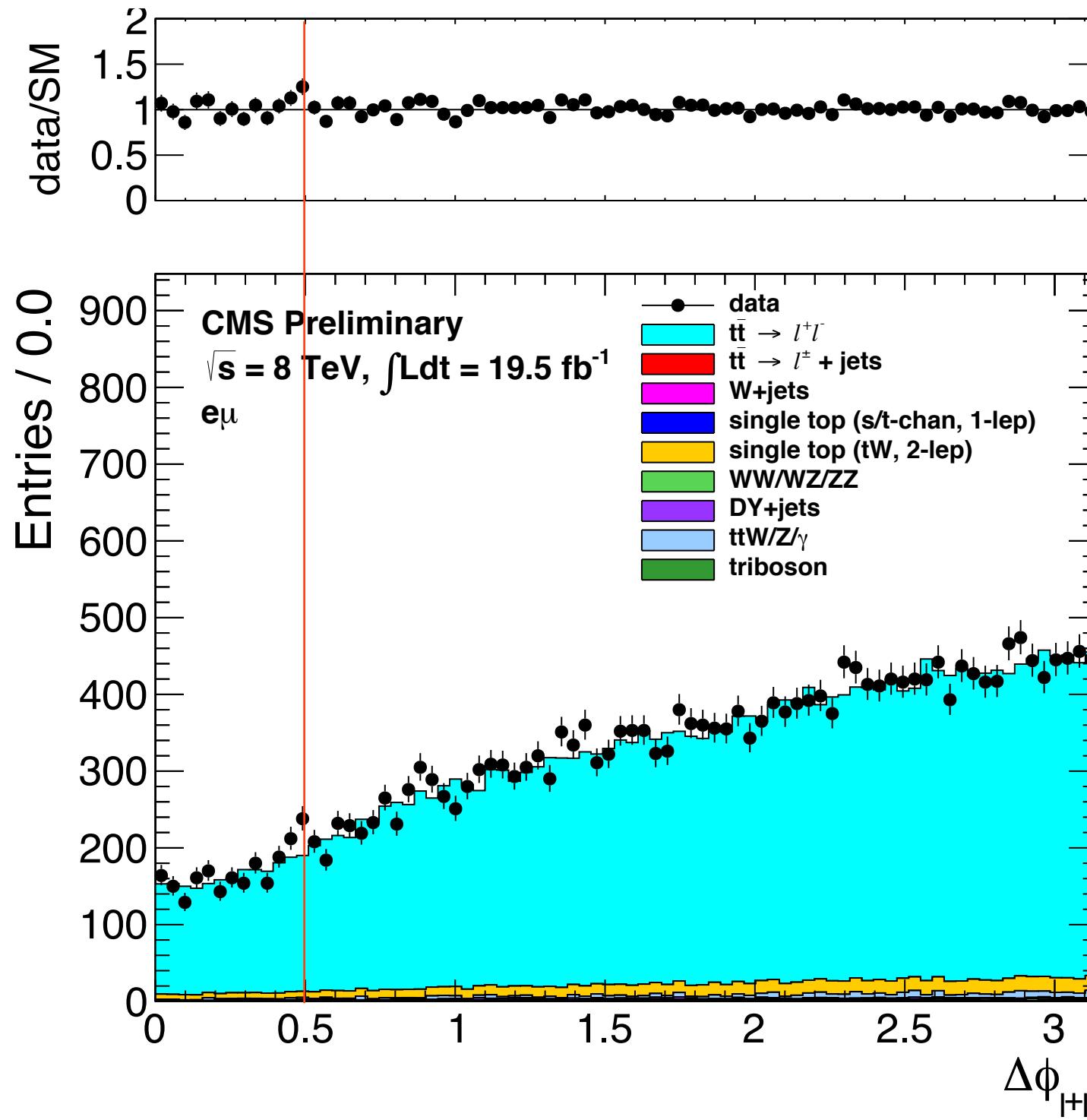
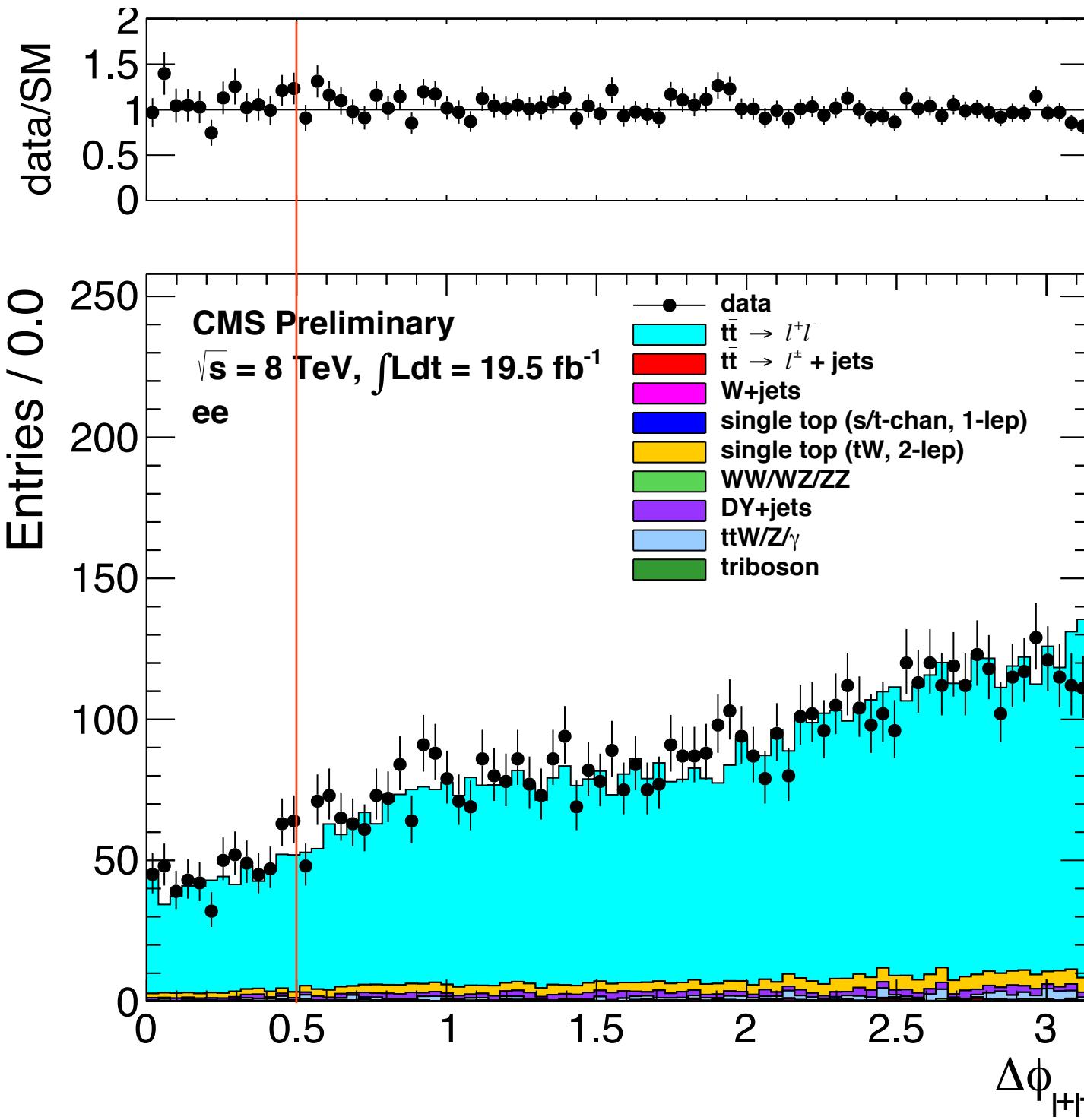
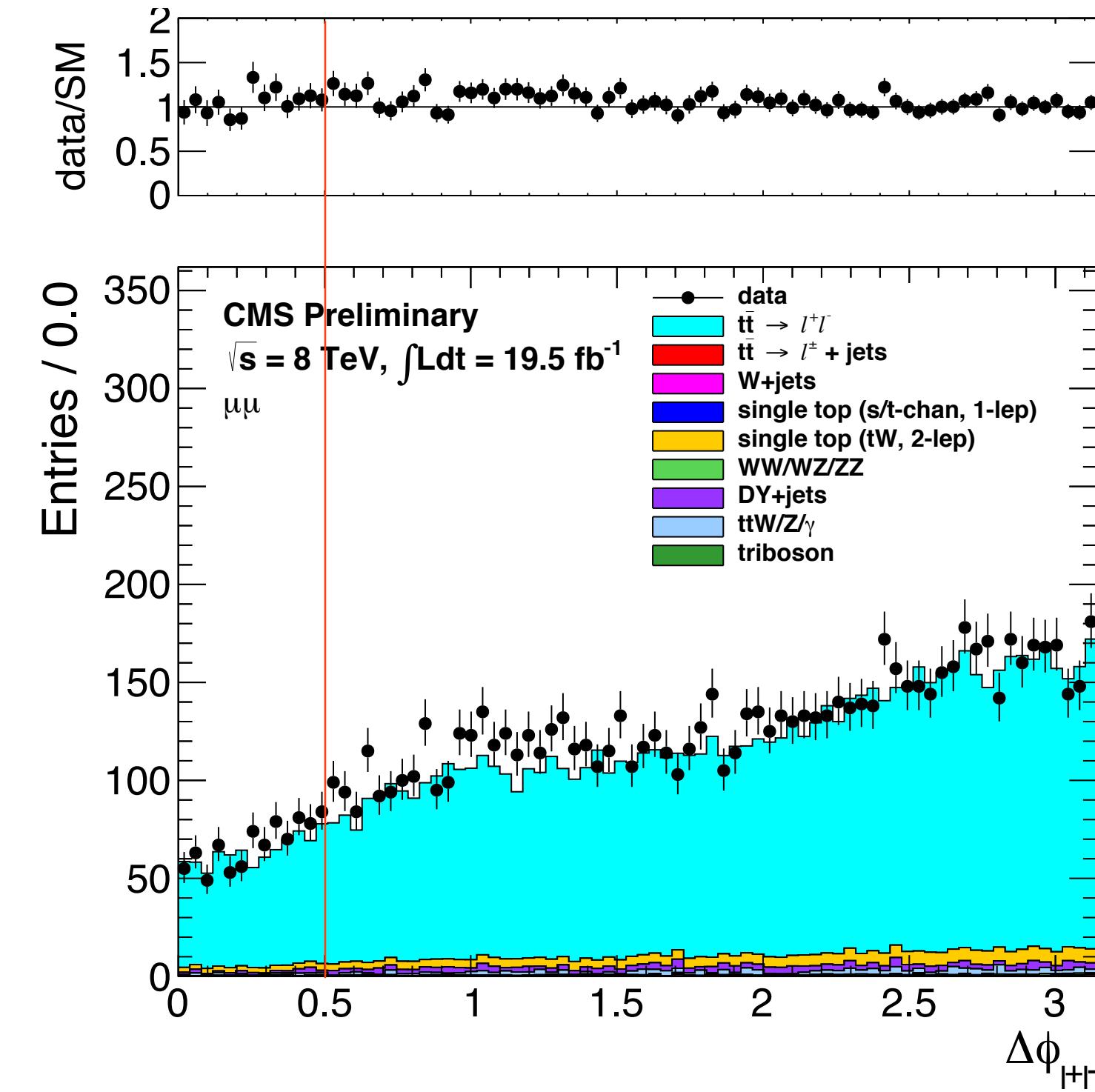


Next 2 slides: raise  $M_{\parallel}$  cut from 20 to 30 GeV (note, 20-30 GeV is the second bin in the above plots)

# Full selection, $\mu\mu$ , $ee$ , $e\mu$ , $M_{ll} > 20$ GeV



# Full selection, $\mu\mu$ , $ee$ , $e\mu$ , $M_{ll} > 30$ GeV

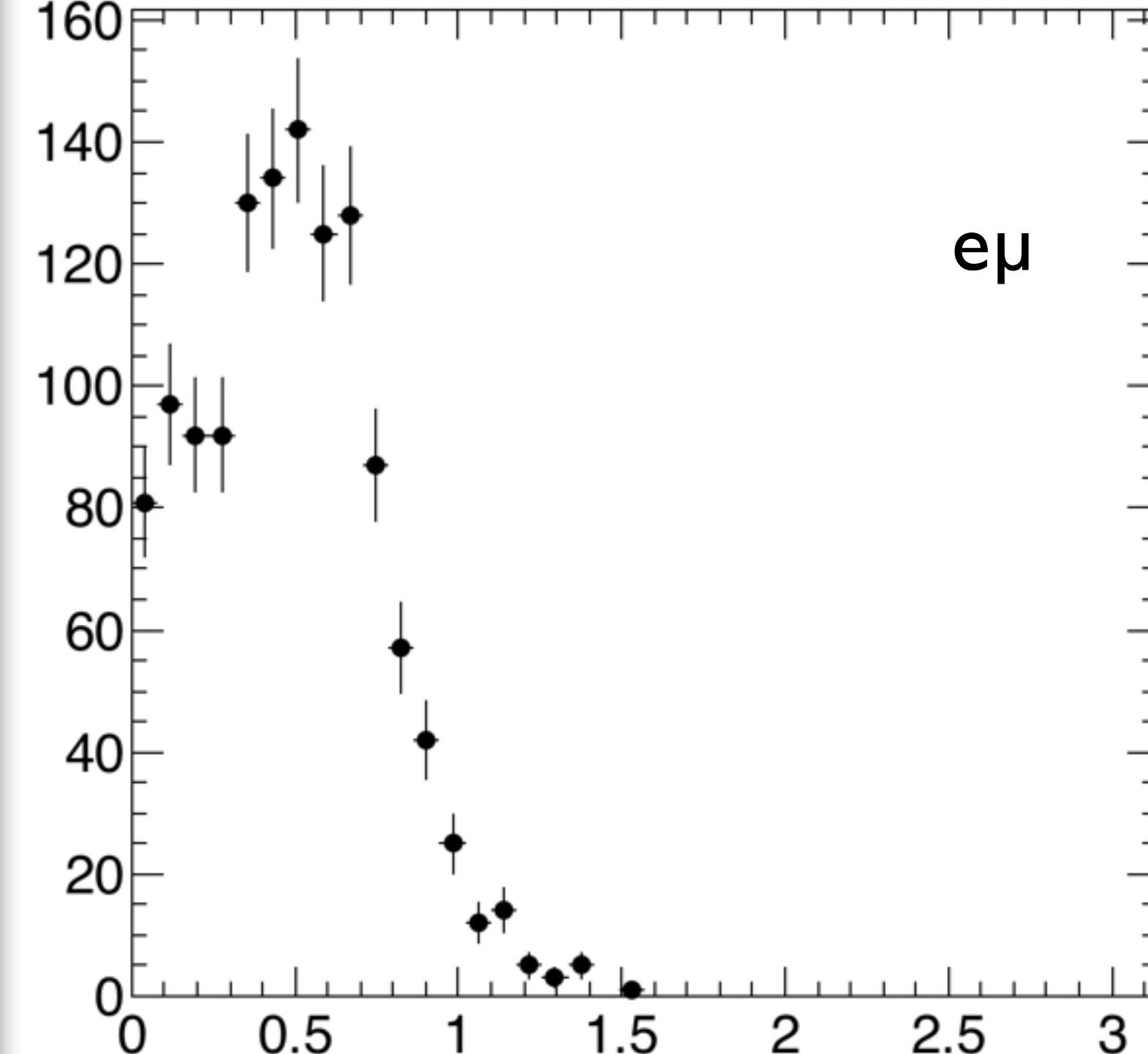
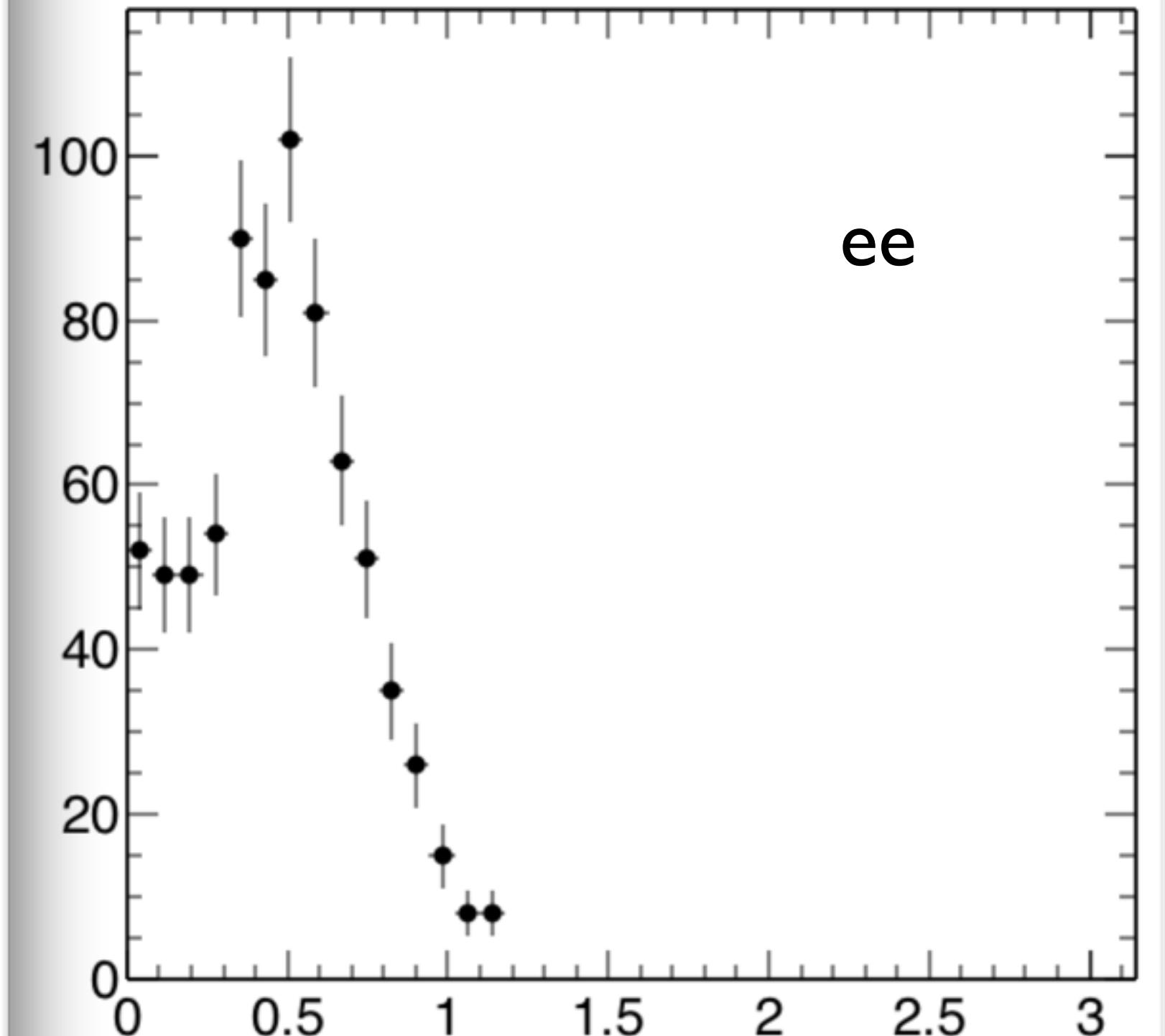
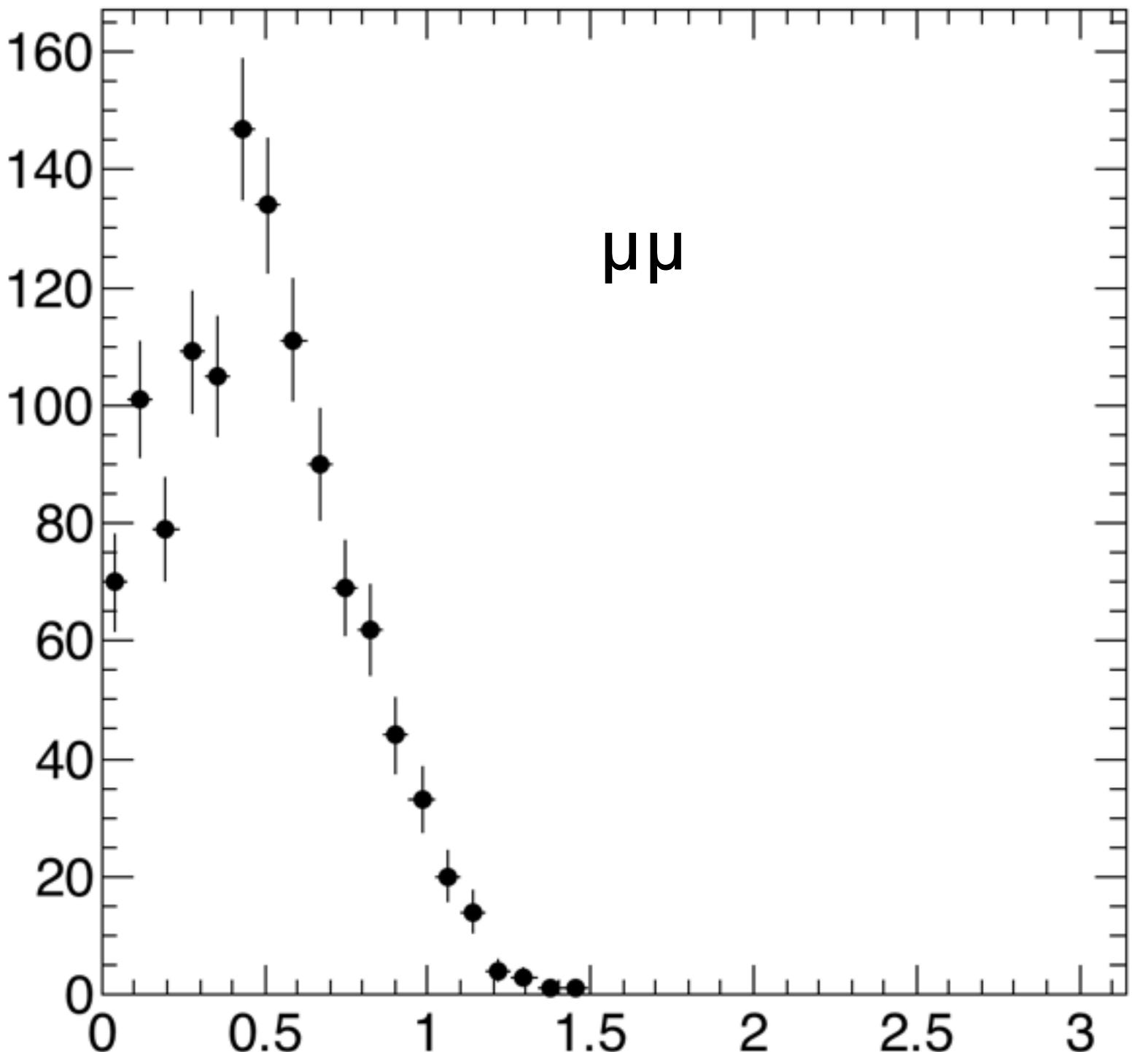


Marginal improvement, but probably not significant?

# data $\Delta\phi$ for $20 < M_{ll} < 30$

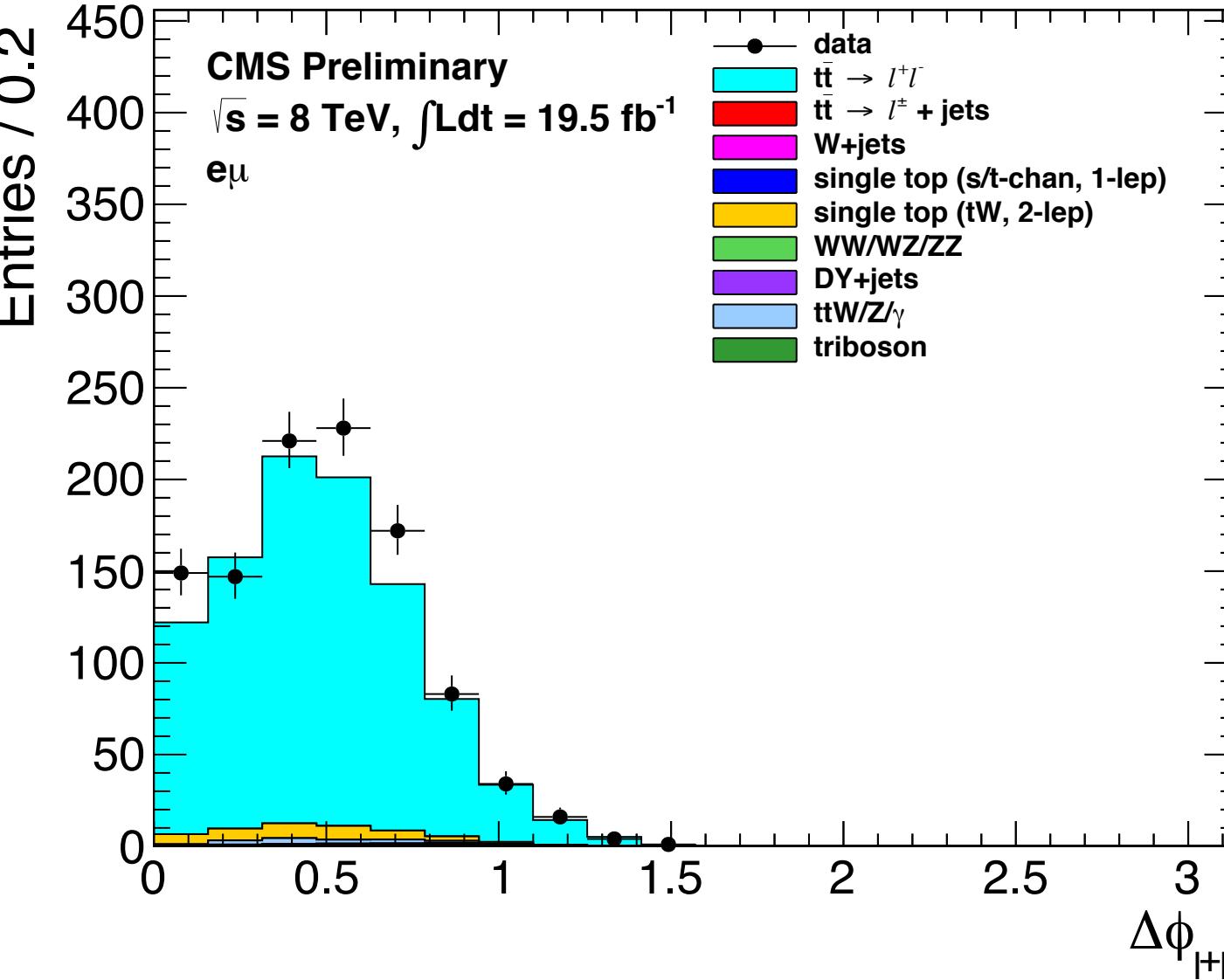
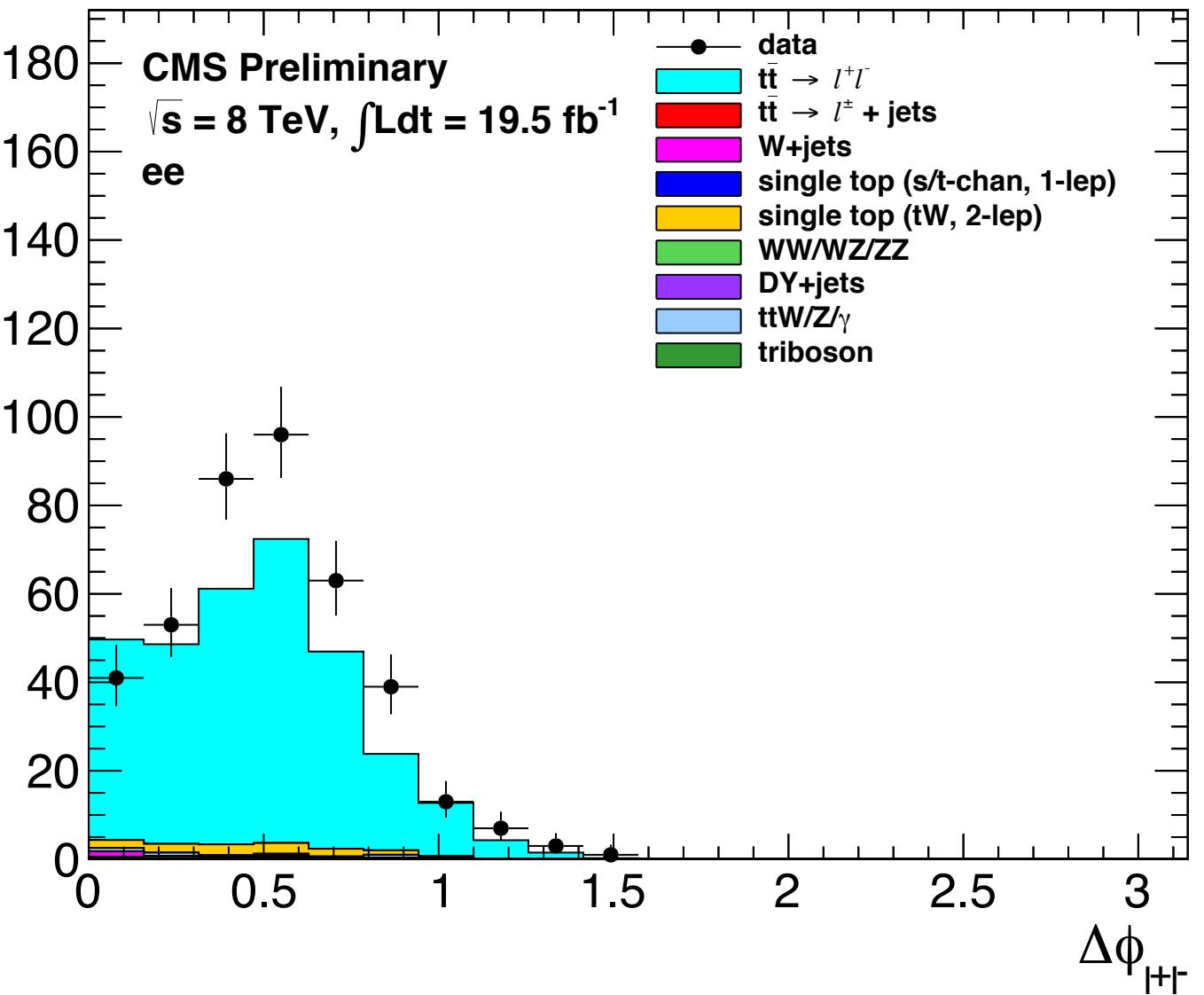
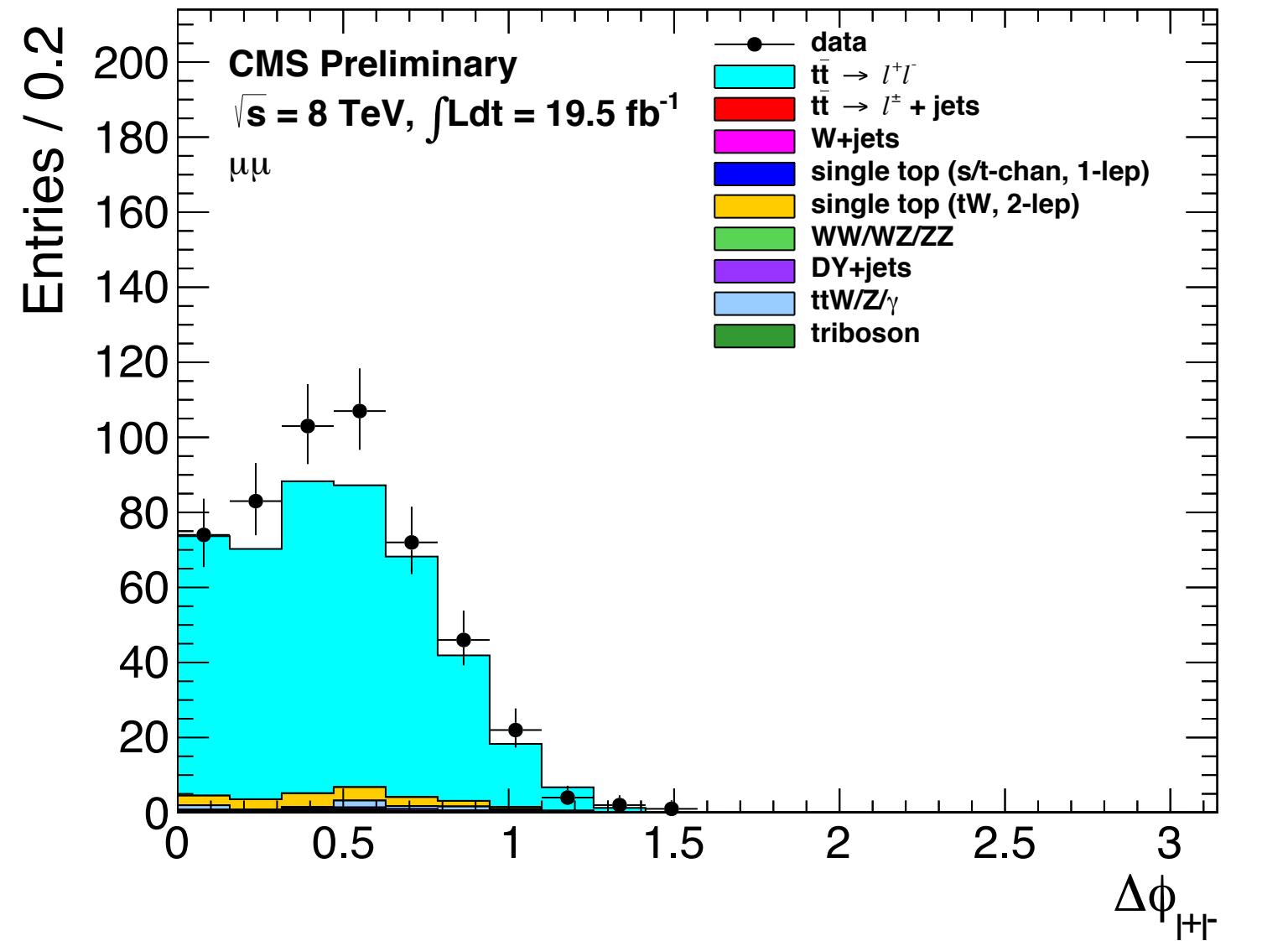
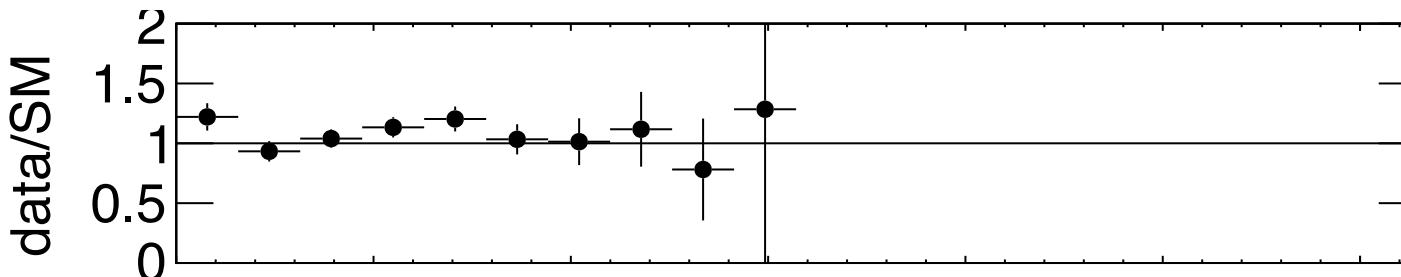
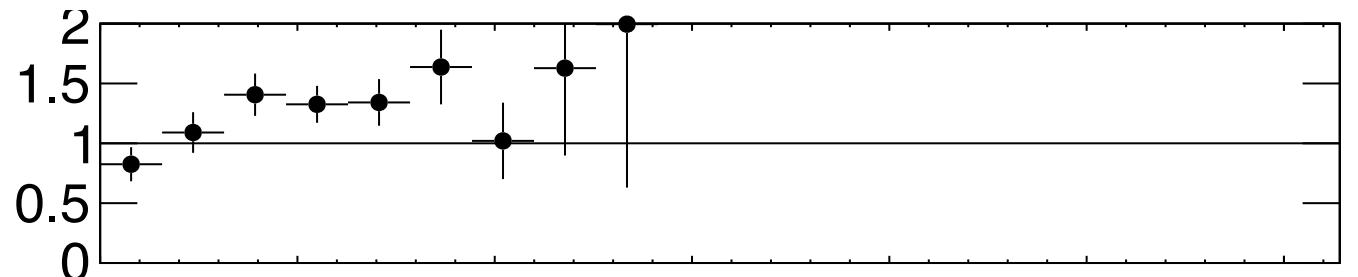
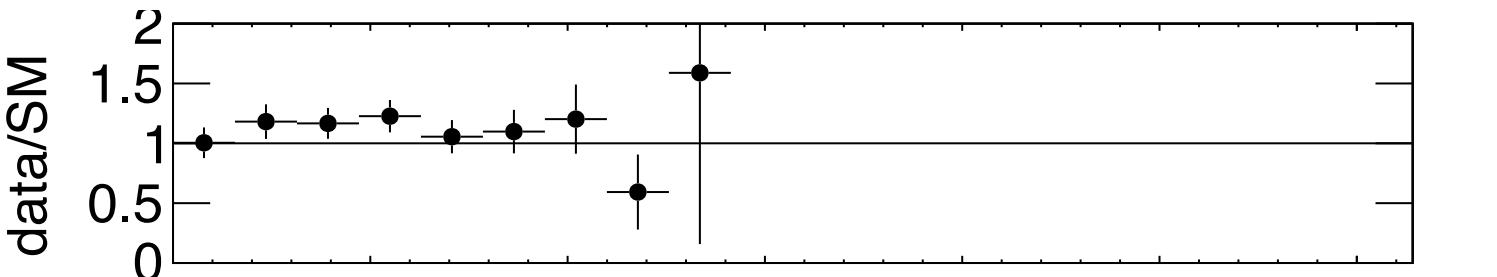
```
t.Draw("acos(cos(lep1.Phi())-lep2.Phi()))>h2(40,0,3.14159265359)", "n good lep == 2 && lep2.Pt() > 20 && nbtagscsvm > 0 && dilmass > 20 && dilmass < 30", "PE")
```

This looks promising, but the peak is at  $\sim 0.5$  for kinematic reasons (above this it's hard to make a mass  $< 30$  GeV): compare to MC on next slide



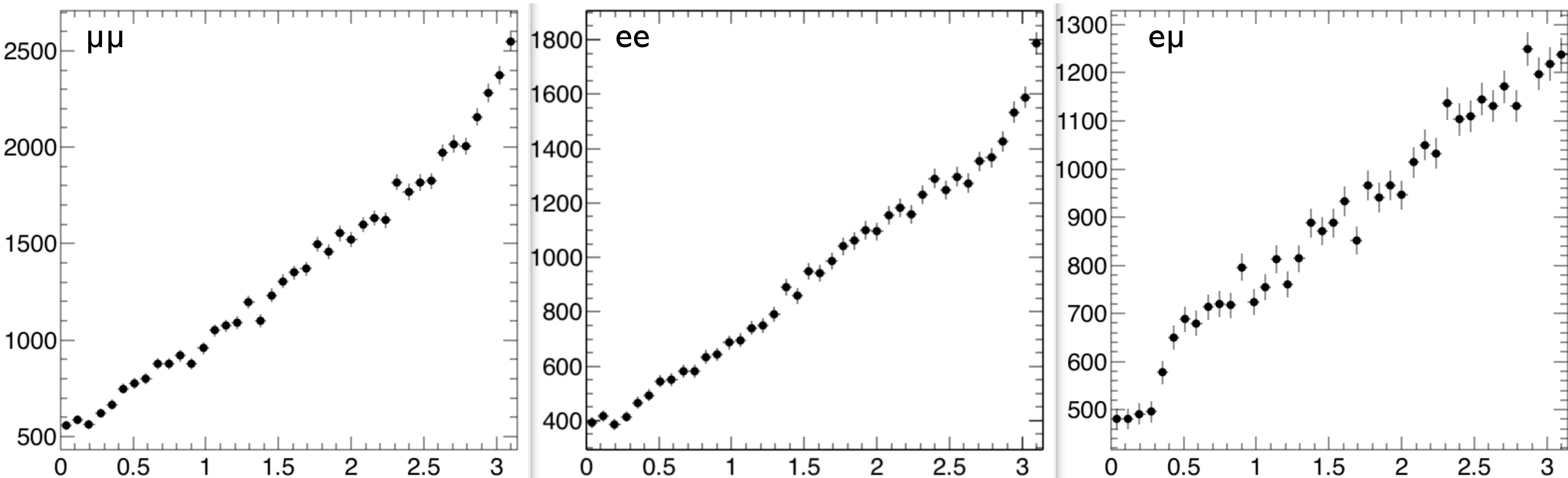
# Full selection, $\mu\mu$ , ee, e $\mu$ , $20 < M_{ll} < 30$ GeV

Overall excess in data, slightly peaked  $\sim 0.5$  in the ratio plots.



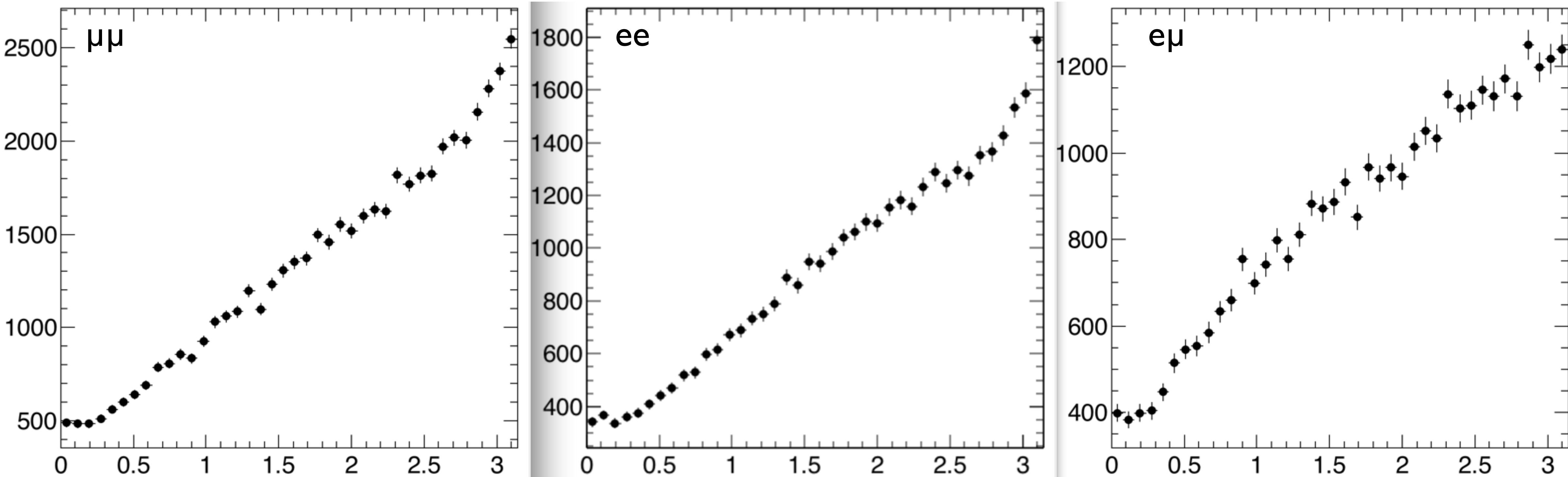
# data $\Delta\phi$ for $M_{ll} > 20$

```
t.Draw("acos(cos(lep1.Phi())-lep2.Phi()))>>h2(40,0,3.14159265359)", "ngoodlep==2 && lep2.Pt()>20 && nbtagscsvm >0 && dilmass>20 && dilmass<30","PE")
```

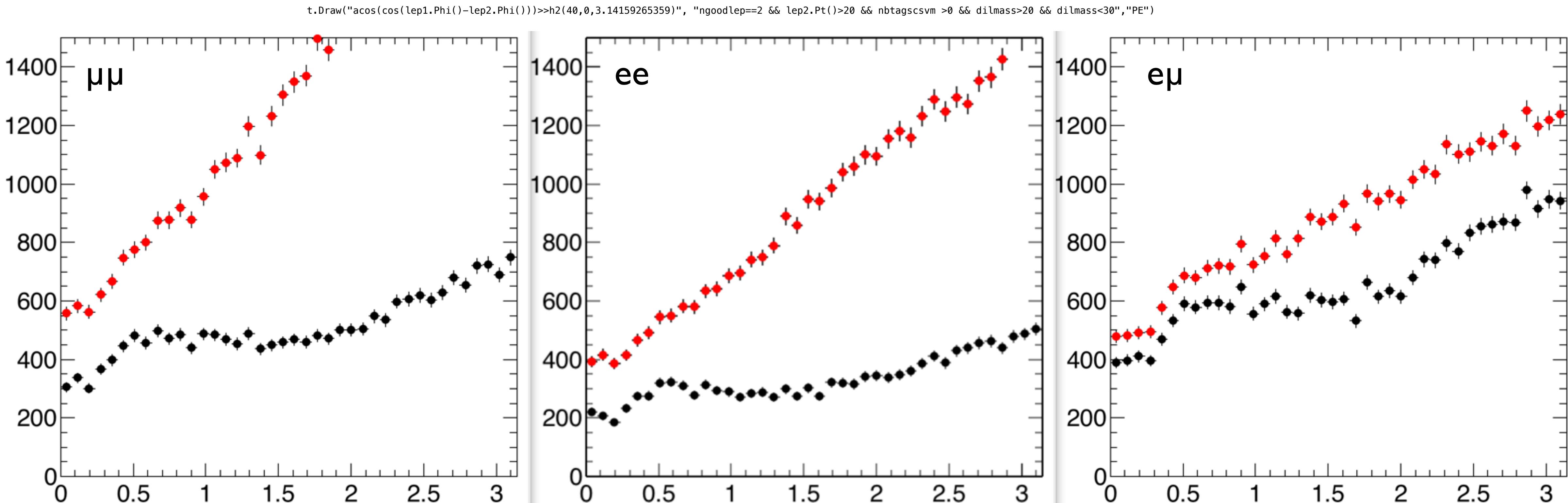


# data $\Delta\phi$ for $M_{ll} > 30$

t.Draw("acos(cos(lep1.Phi())-lep2.Phi()))>>h2(40,0,3.14159265359)", "ngoodlep==2 && lep2.Pt()>20 && nbtagscsvm >0 && dilmass>20 && dilmass<30","PE")

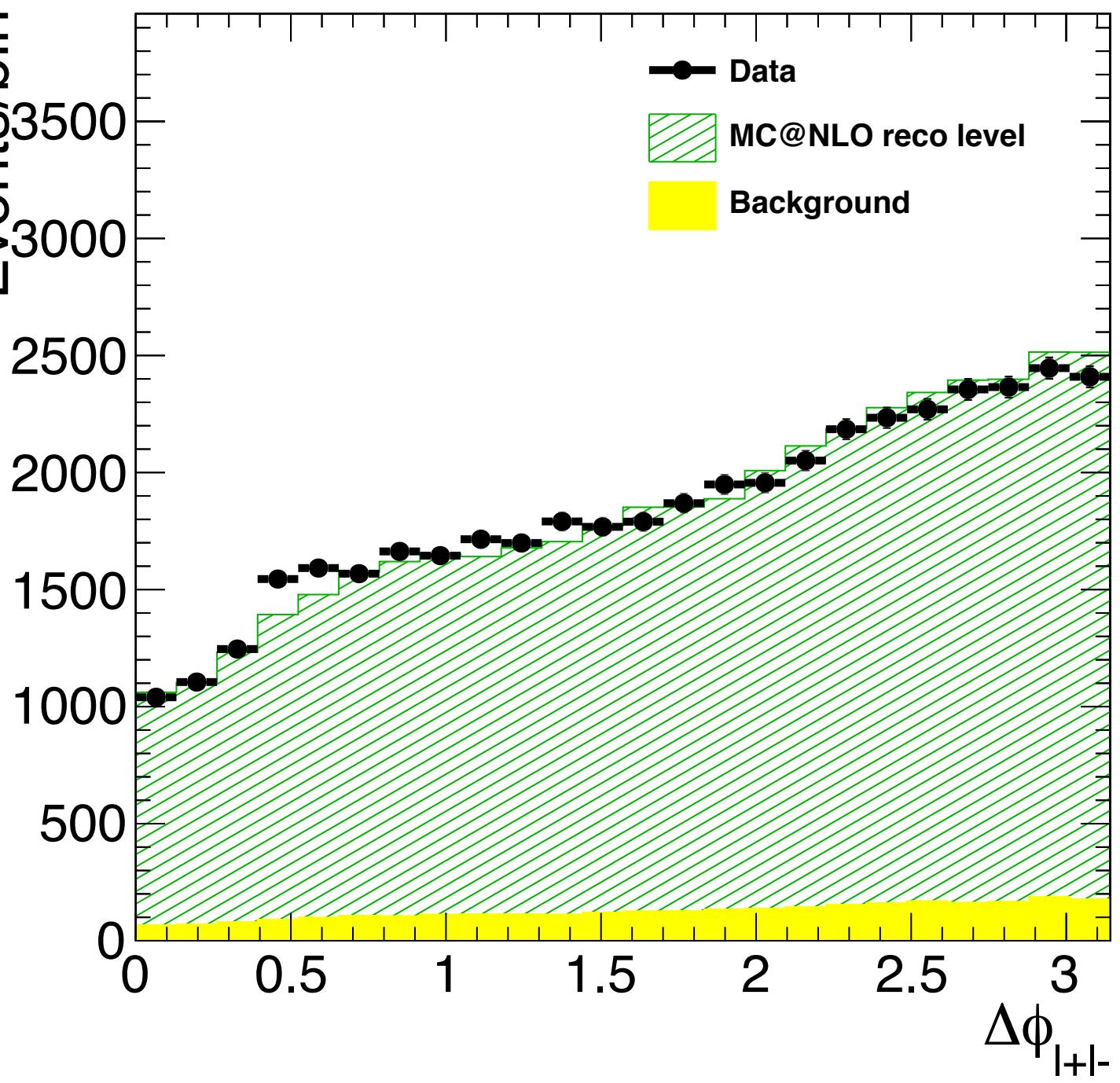


# data $\Delta\phi$ for $M_{ll} > 20$ , with and without Z veto



# Significance estimate

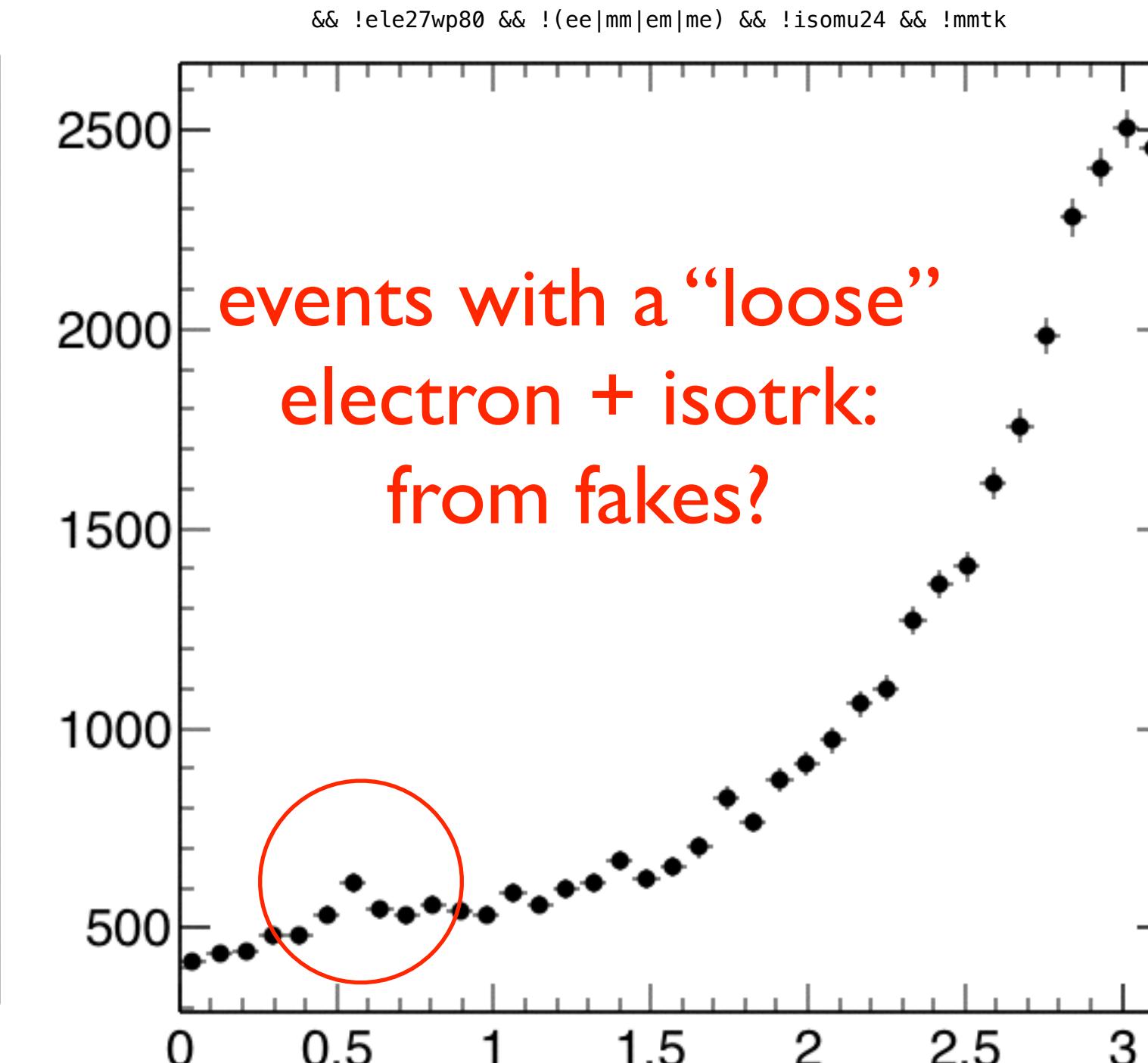
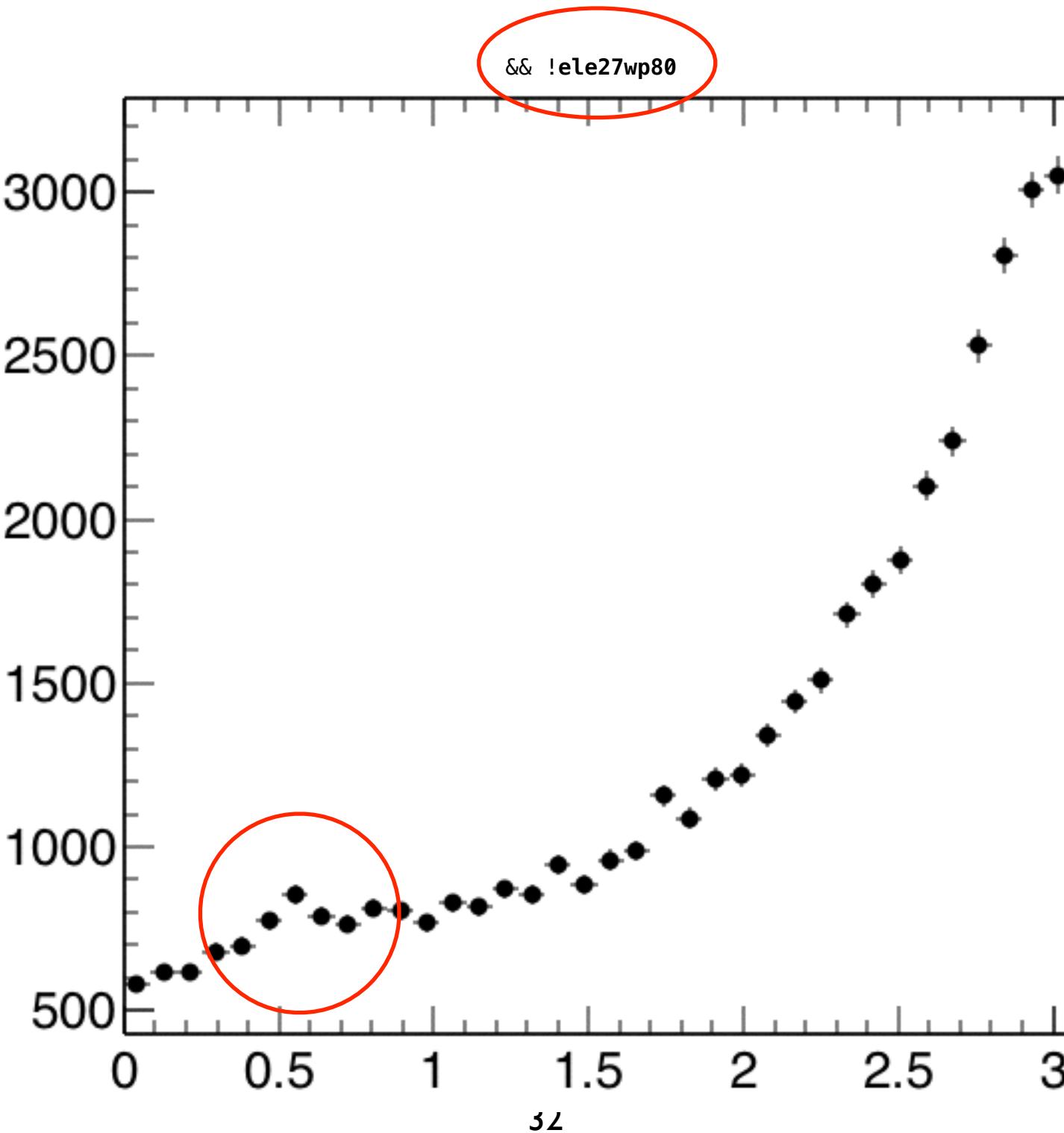
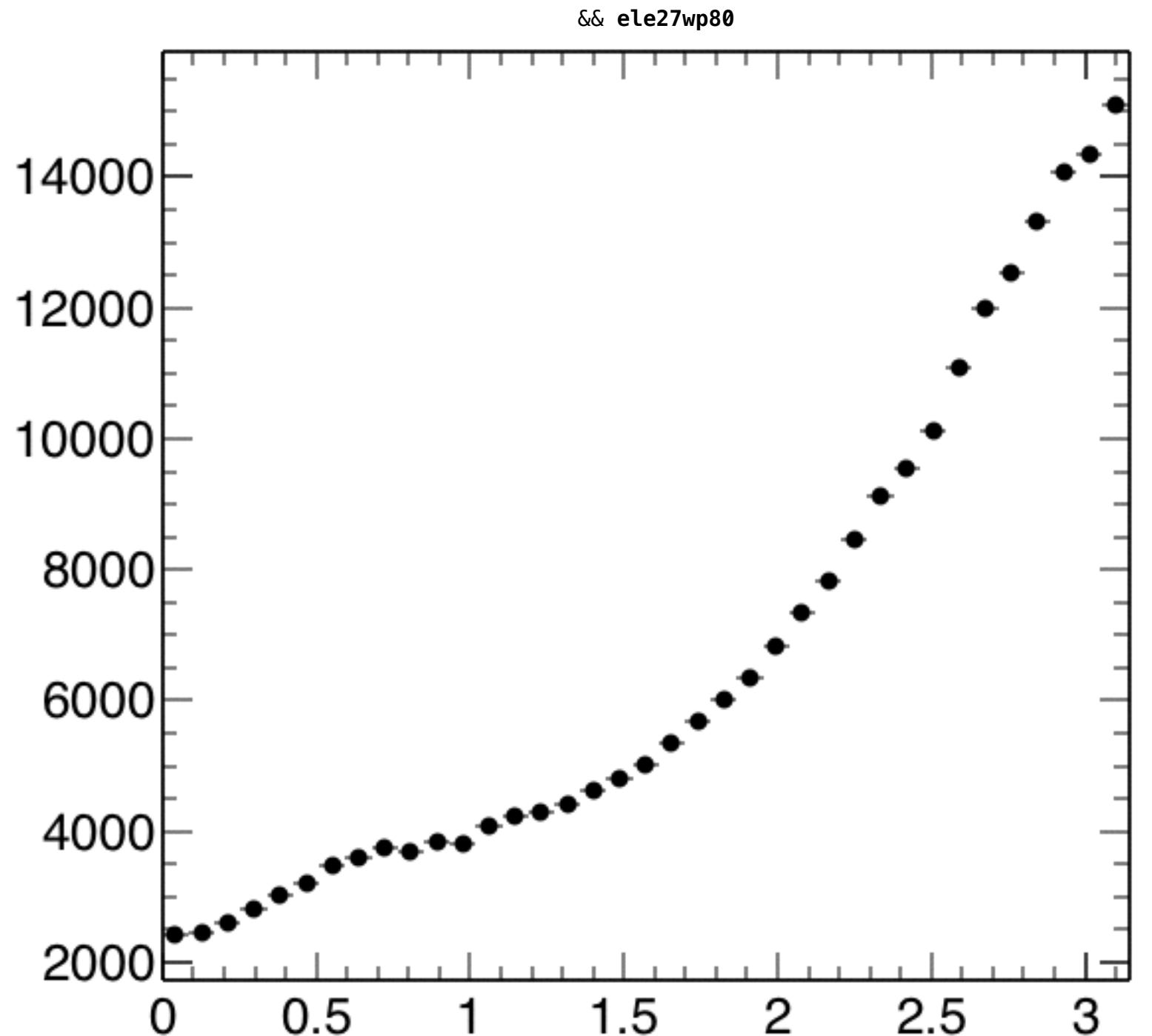
- The plot shows the reco-level distribution to be used as input to the unfolding. The MC is normalised to the data.
  - No top pT reweighting is applied. It would make the agreement worse, as we saw in 7 TeV (MC slope would be steeper).
  - Calculate significance of the two high bins near 0.5, using data and MC stat uncertainties
    - bin3: 3.5sigma, bin4: 2.6sigma, combined: 4.3sigma
    - of course LEE is not included here, so the combined significance is not compelling
  - If we were to double the bin widths the significance would be significantly reduced because the bump would be spread across 2 wide bins (bin2: 2.8 sigma and bin3: 1.7 sigma)



# Backup

# Single electron + isotrk

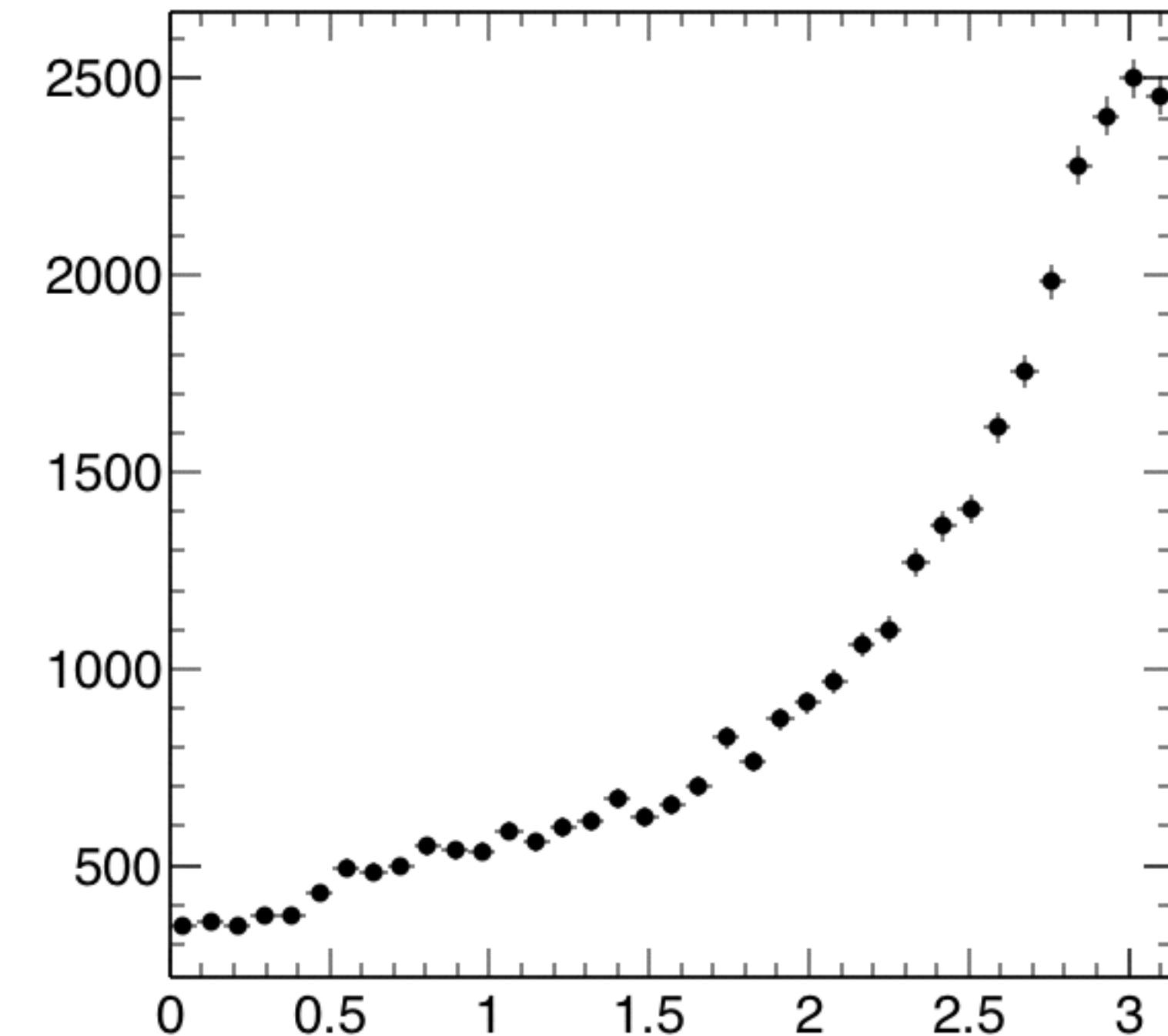
```
t.Draw("abs(2*asin(sin(lep1.Phi())/2.-pfcand0S10.Phi()/2.))>>h2(37,0,3.14159265359)", "ngoodlep==1 && sqrt( (lep1.E() + pfcand0S10.E())^2 - (lep1.Px() + pfcand0S10.Px())^2 - (lep1.Py() + pfcand0S10.Py())^2 - (lep1.Pz() + pfcand0S10.Pz())^2 ) >12 && pfcand0S10.Pt(>20 && nbtagscsvm !=0", "PE")
```



# Single electron + isotrk

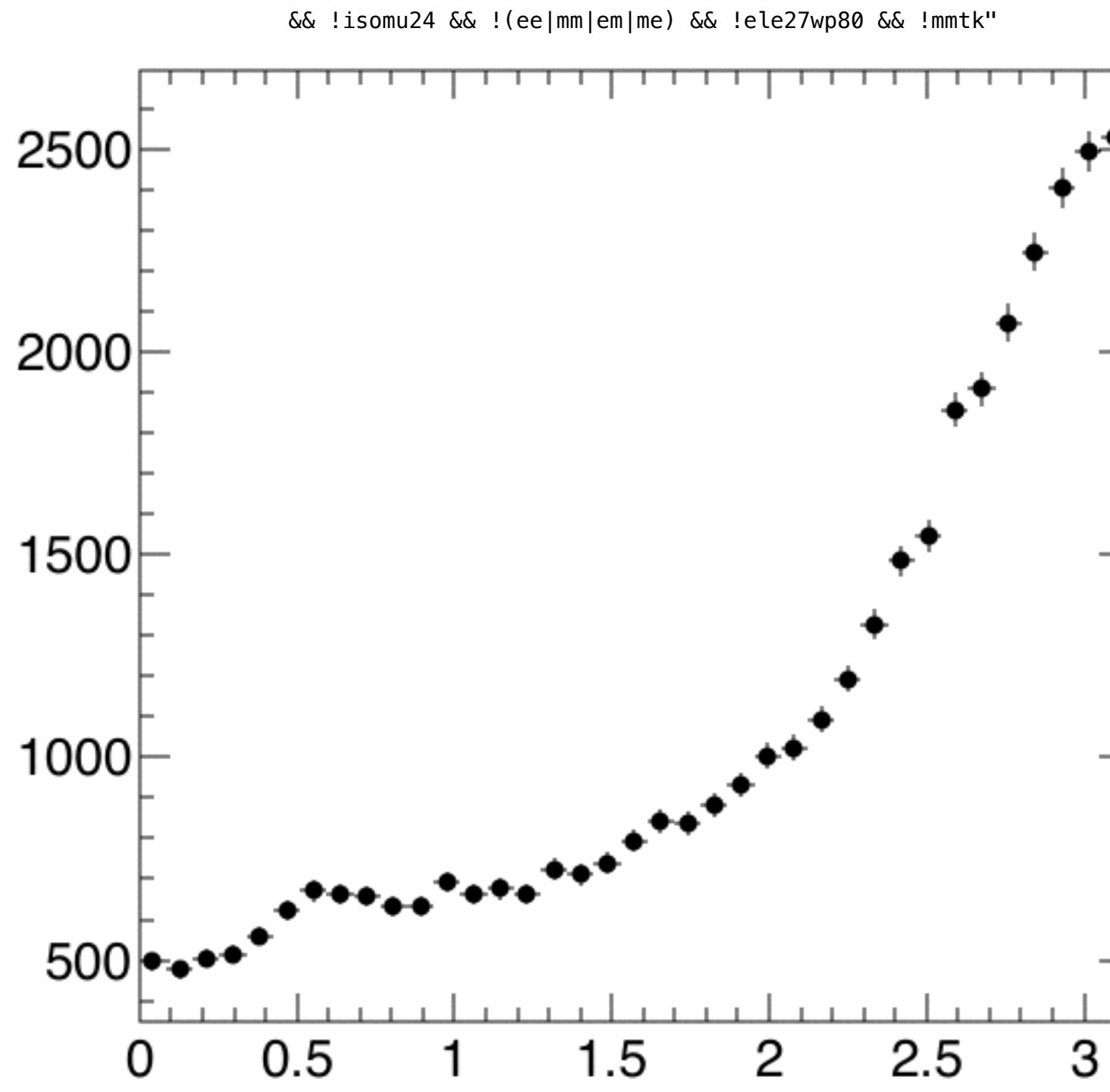
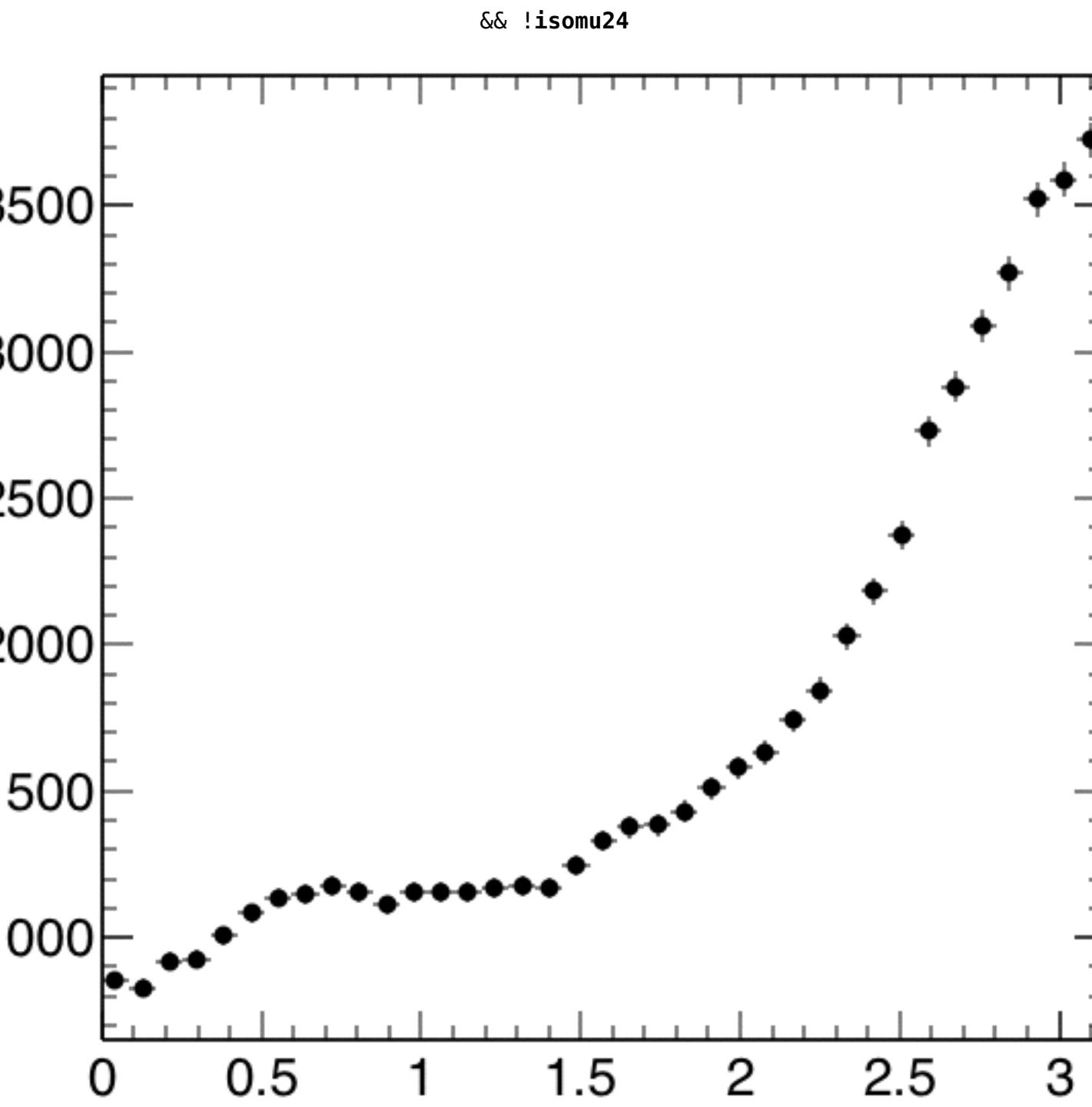
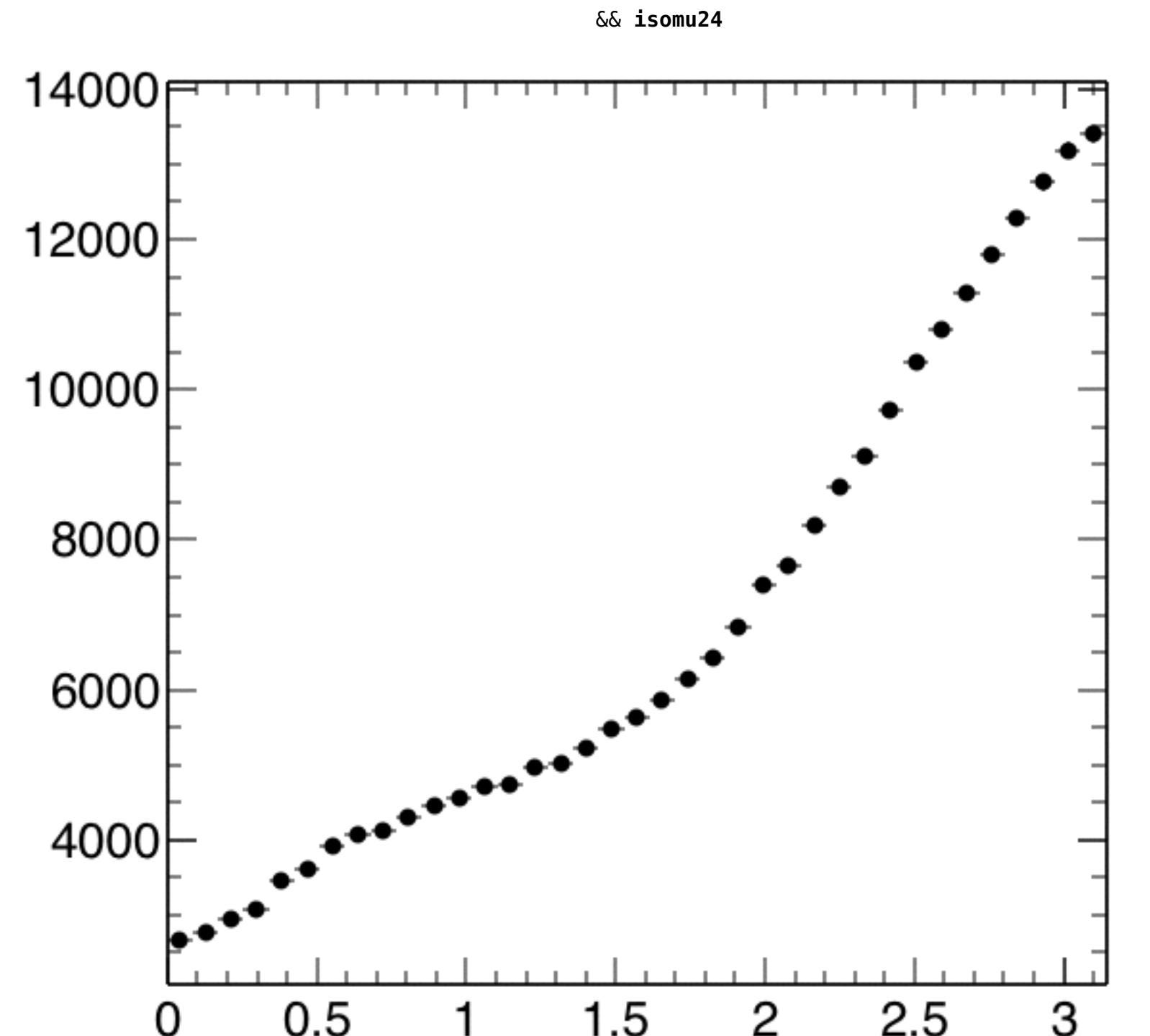
```
t.Draw("abs(2*asin(sin(lep1.Phi())/2.-pfcand0S10.Phi()/2.))>>h2(37,0,3.14159265359)", "ngoodlep==1 && sqrt( (lep1.E() + pfcand0S10.E())^2 - (lep1.Px() + pfcand0S10.Px())^2 - (lep1.Py() + pfcand0S10.Py())^2 - (lep1.Pz() + pfcand0S10.Pz())^2 ) >20 && pfcand0S10.Pt(>20 && nbtagscsvm !=0", "PE")  
  
 && !ele27wp80 && !(ee|mm|em|me) && !isomu24 && !mmtk
```

but it mostly disappears  
when increasing  $m_{\parallel}$  cut  
from 12 to 20



# Single muon + isotrk

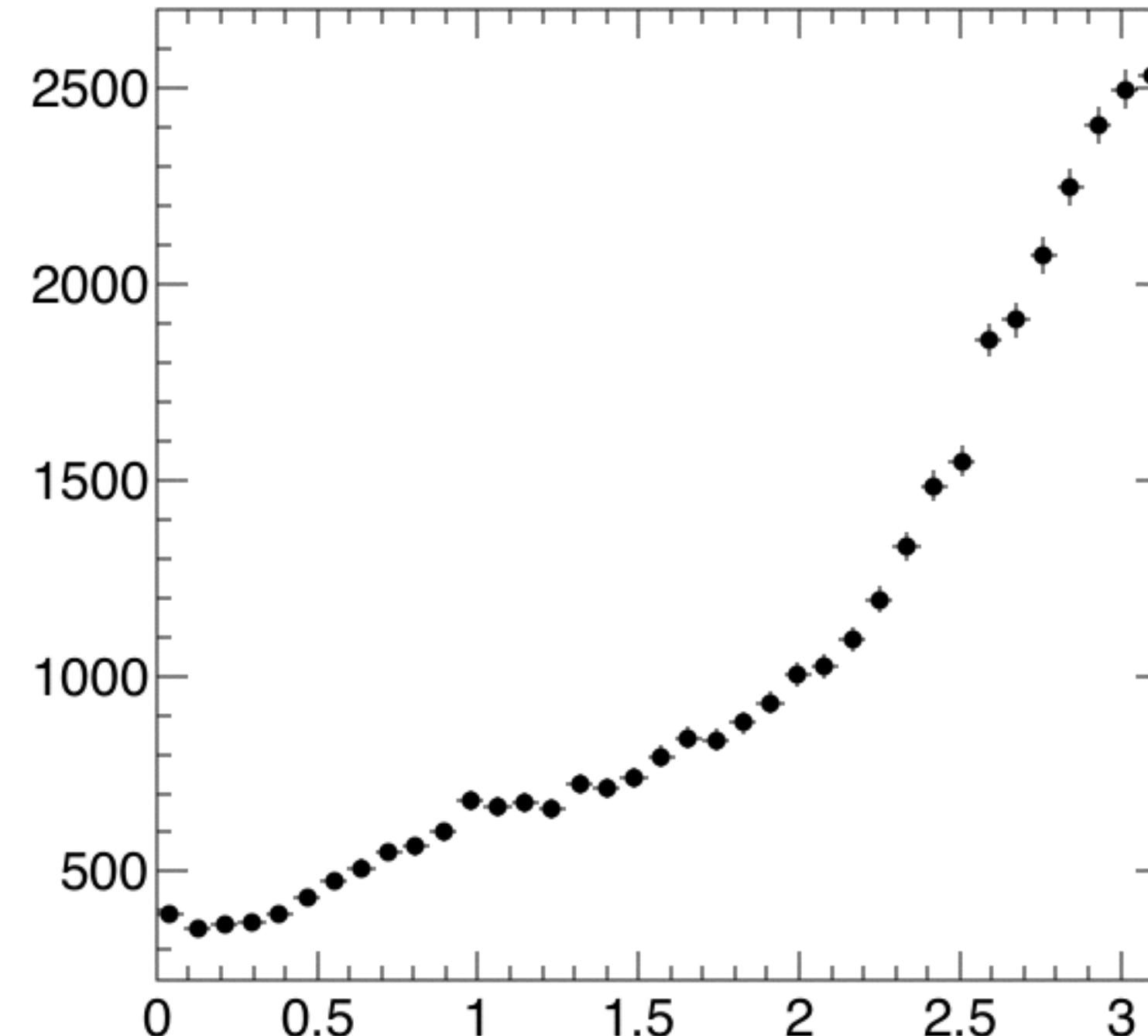
```
t.Draw("abs(2*asin(sin(lep1.Phi())/2.-pfcand0S10.Phi()/2.))>>h2(37,0,3.14159265359)", "ngoodlep==1 && sqrt( (lep1.E() + pfcand0S10.E())^2 - (lep1.Px() + pfcand0S10.Px())^2 - (lep1.Py() + pfcand0S10.Py())^2 - (lep1.Pz() + pfcand0S10.Pz())^2 ) >12 && pfcand0S10.Pt(>20 && nbtagscsvm !=0", "PE")
```



# Single muon + isotrk

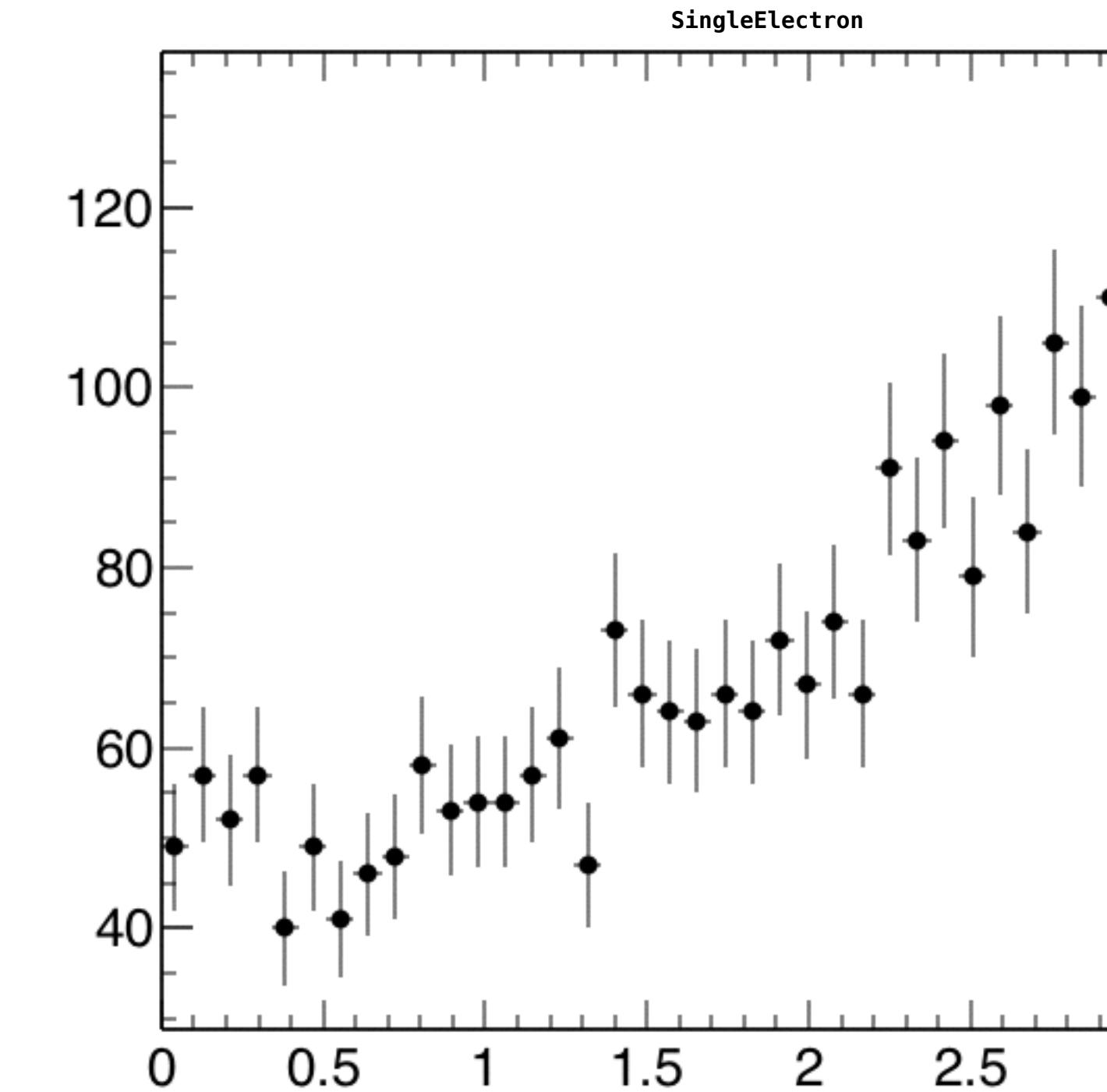
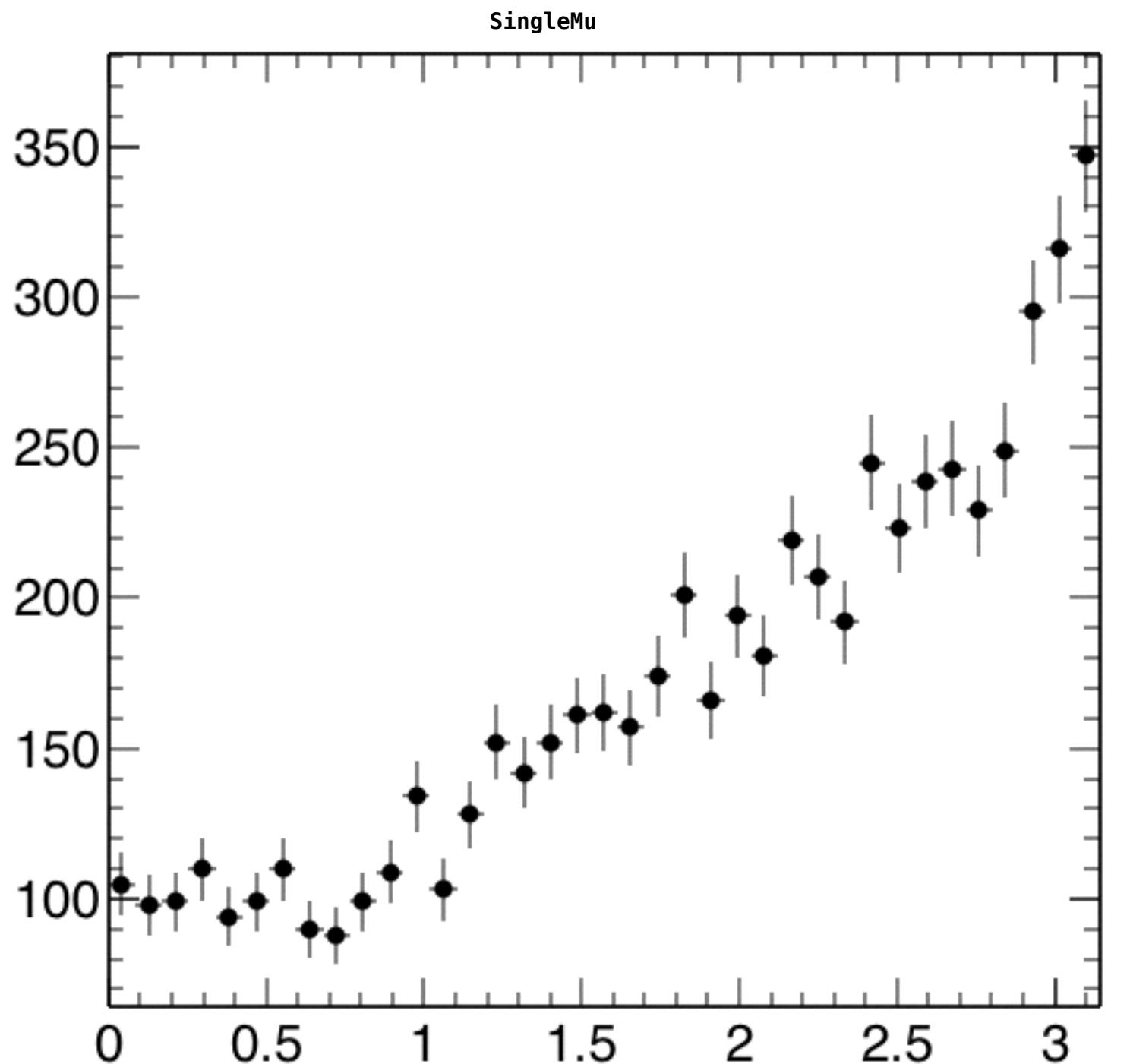
```
t.Draw("abs(2*asin(sin(lep1.Phi())/2.-pfcand0S10.Phi()/2.))>>h2(37,0,3.14159265359)", "ngoodlep==1 && sqrt( (lep1.E() + pfcand0S10.E())^2 - (lep1.Px() + pfcand0S10.Px())^2 - (lep1.Py() + pfcand0S10.Py())^2 - (lep1.Pz() + pfcand0S10.Pz())^2 ) >20 && pfcand0S10.Pt(>20 && nbtagscsvm !=0", "PE")
```

```
&& !isomu24 && !(ee|mm|em|me) && !ele27wp80 && !mmtk"
```



# Single lepton dataset, 2 good leptons, but not dilepton trigger

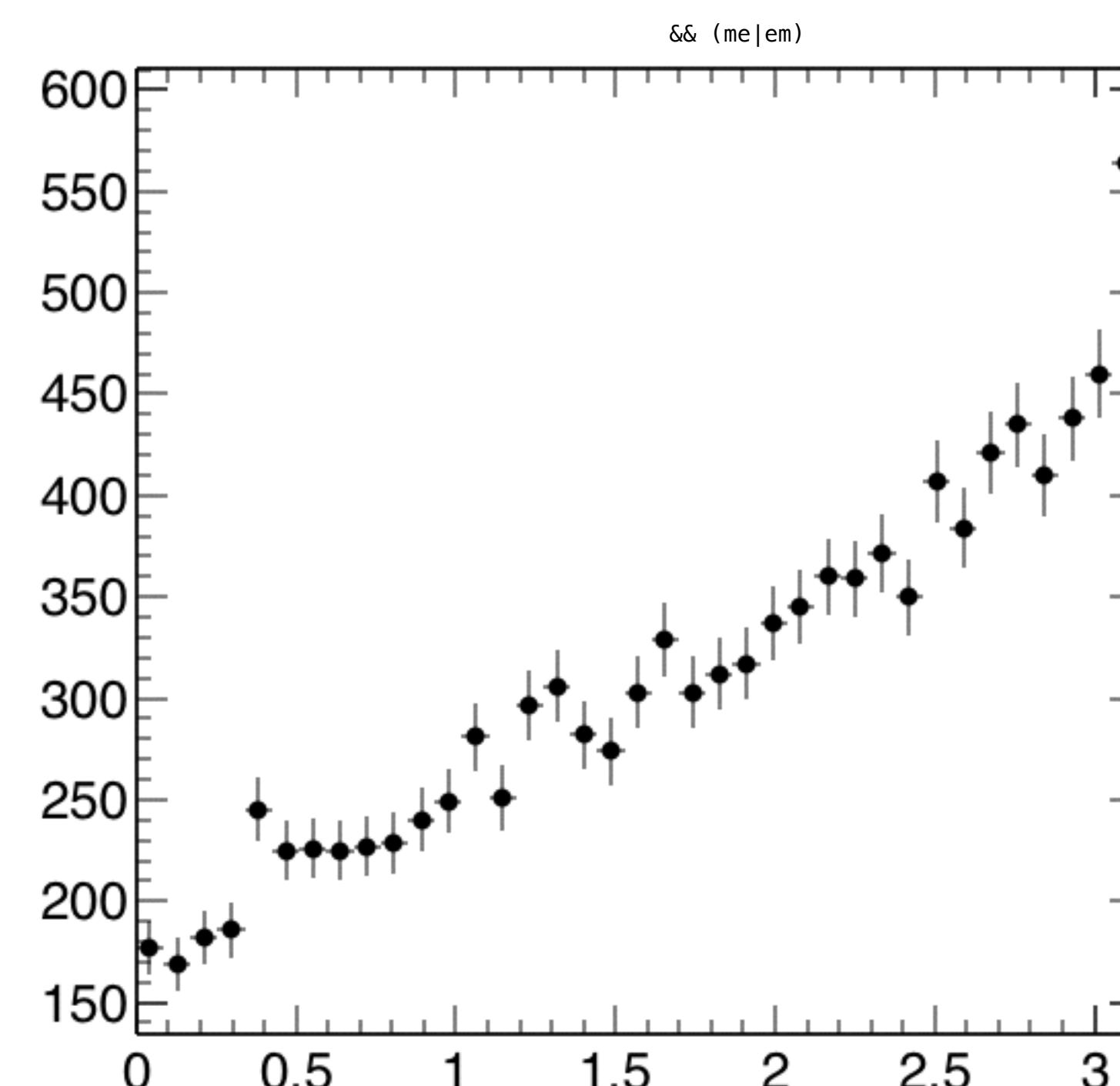
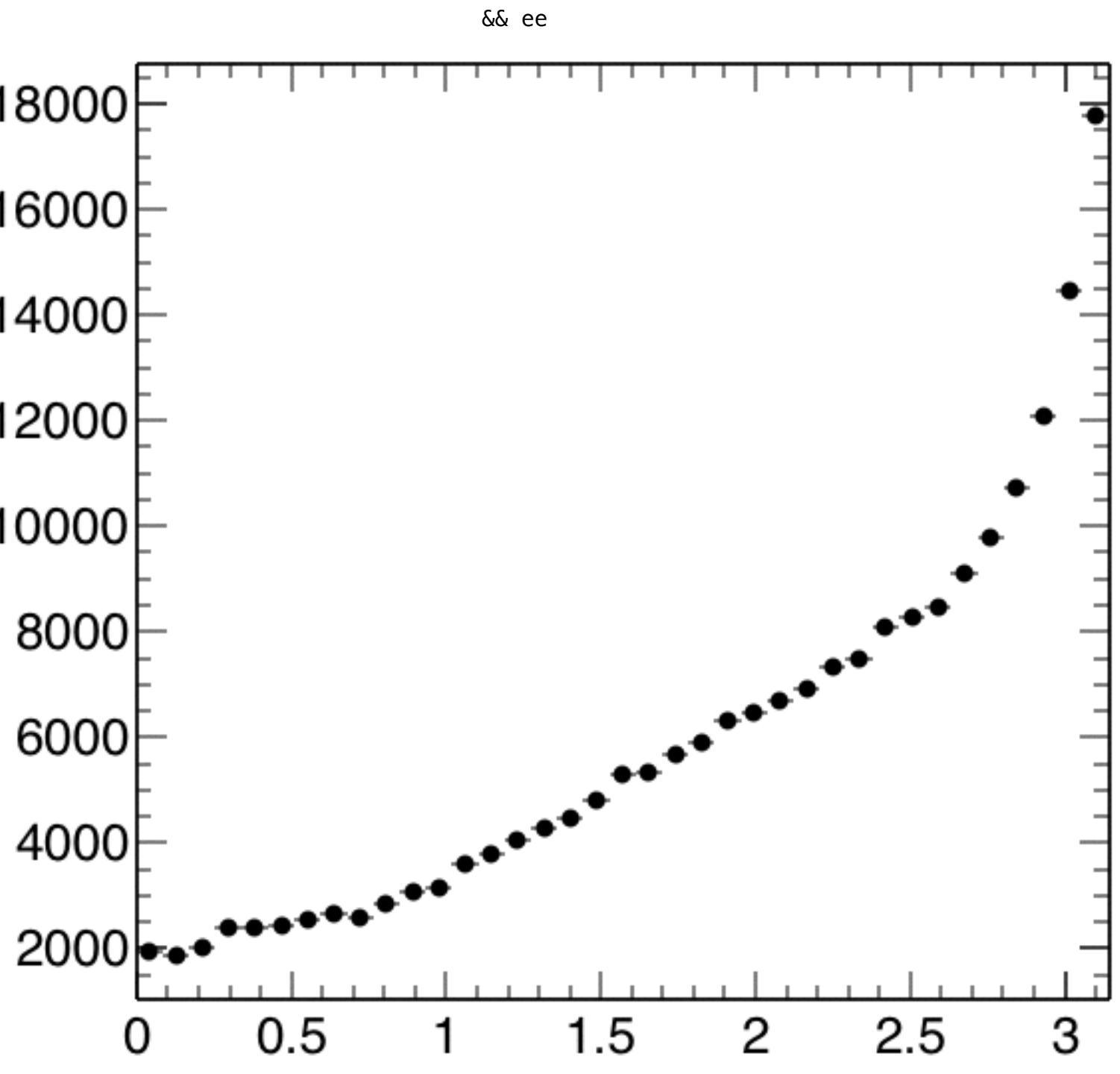
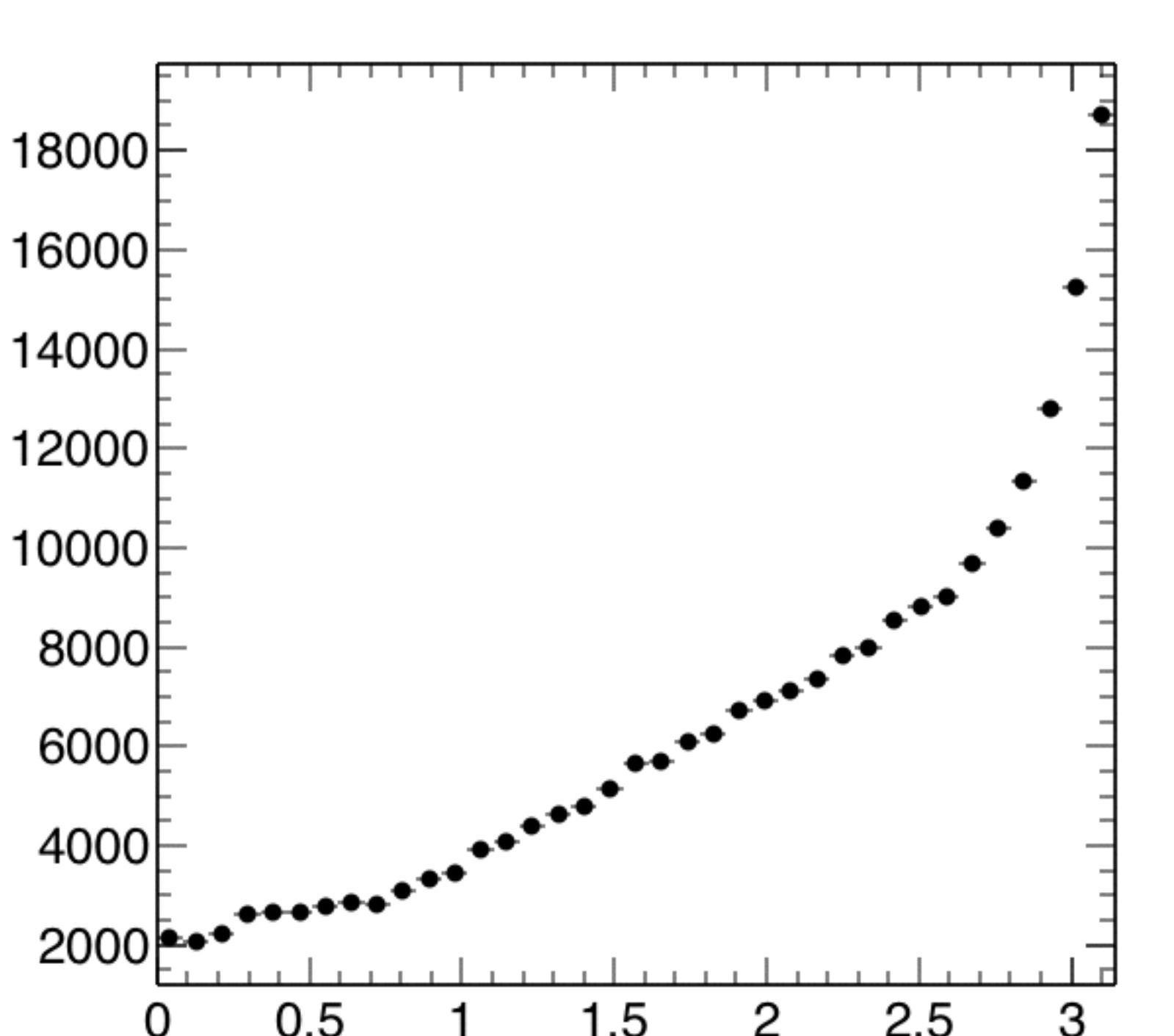
```
t.Draw("acos(cos(lep1.Phi())-lep2.Phi()))>>h2(37,0,3.14159265359)", "ngoodlep==2 && id1*id2<0 && dilmass>12 && lep2.Pt()>20 && nbtagscsvm !=0 && !(me|em|mm|ee)","PE")
```



- remaining plots are probably not of interest

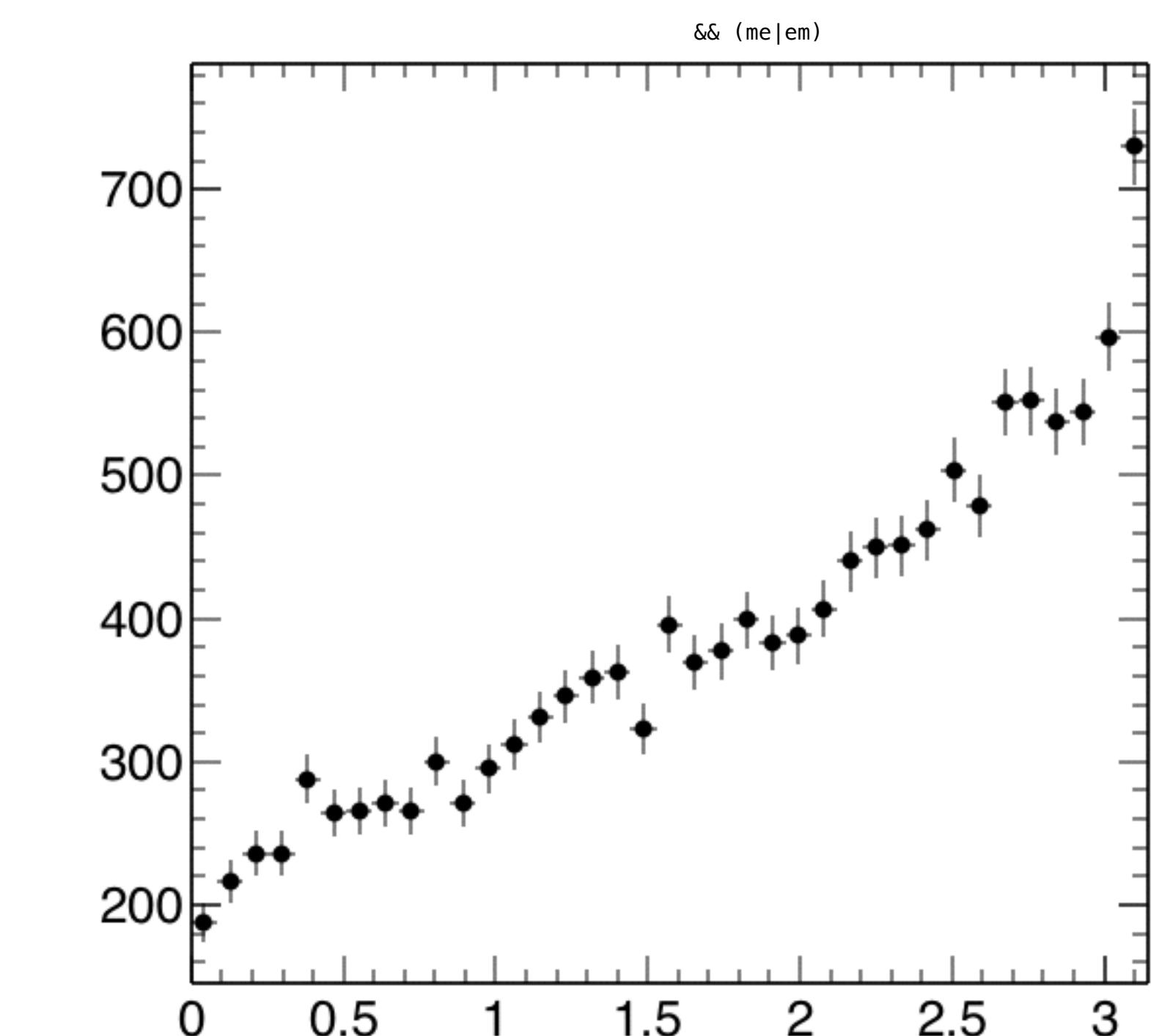
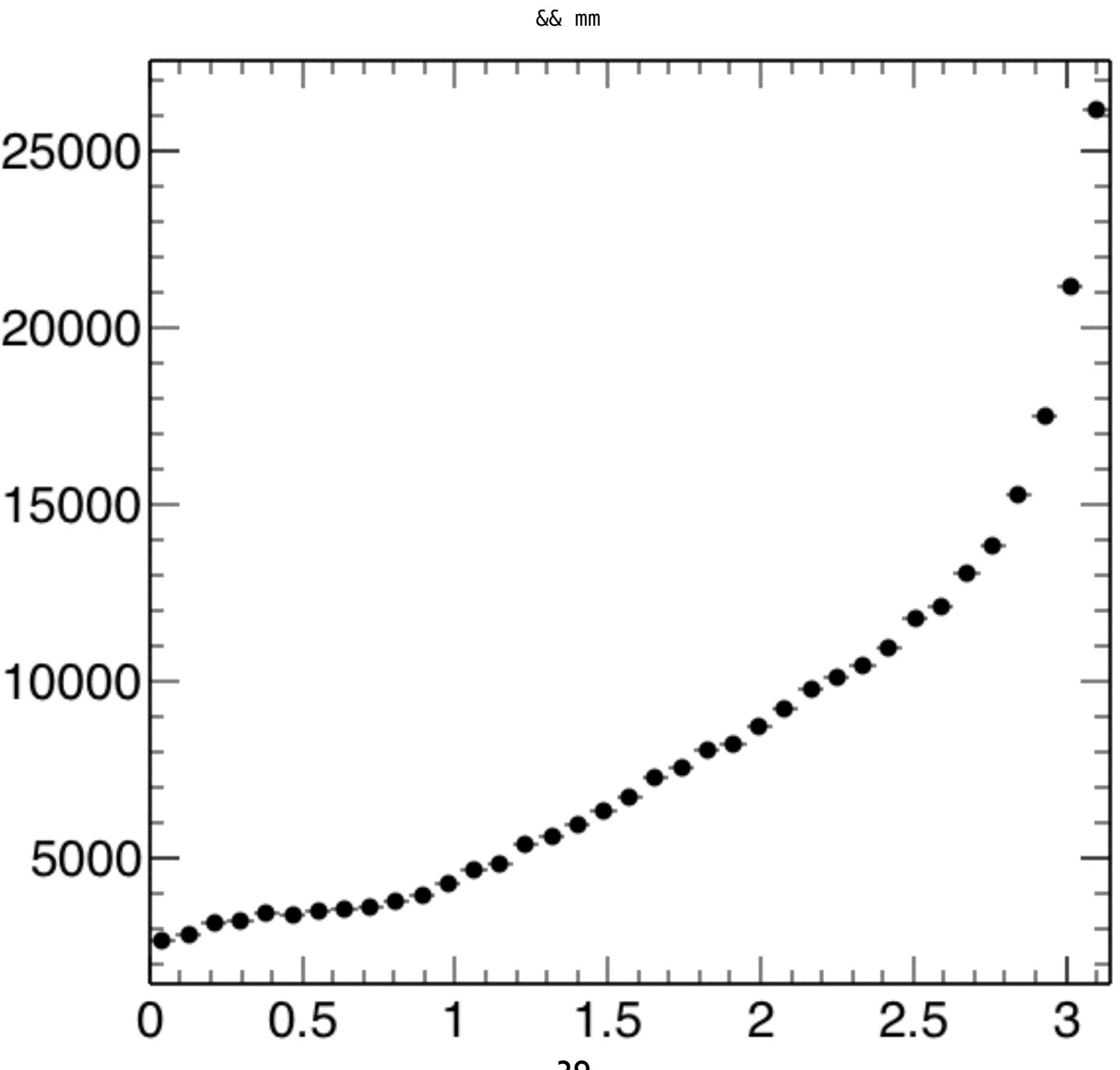
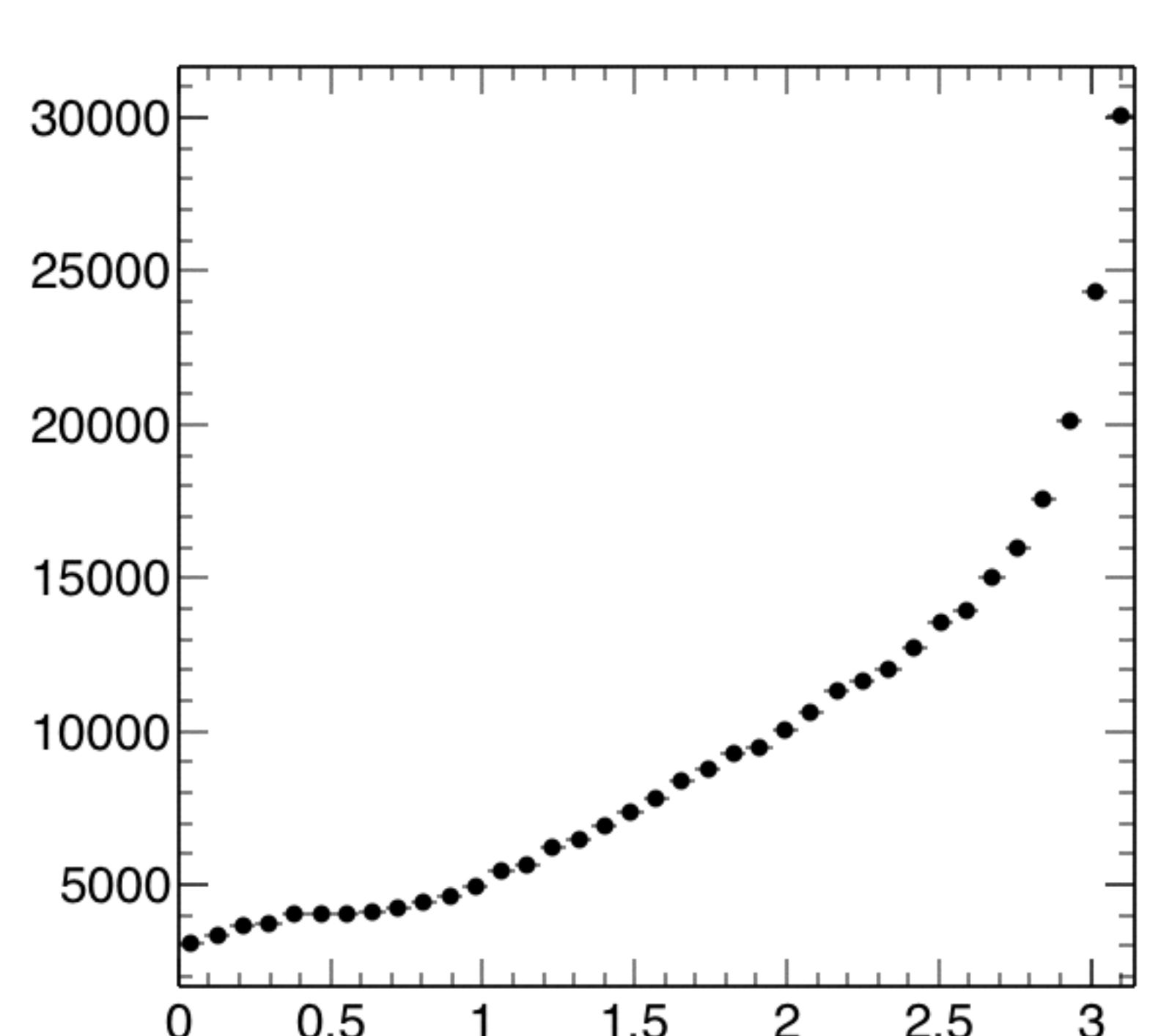
# Single electron dataset and trigger, no b-tags

```
t.Draw("abs(2*asin(sin(id1*lep1.Phi()/2./abs(id1)+id2*lep2.Phi()/2./abs(id2))))>>h2(37,0,3.14159265359)", "ngoodlep==2 && id1*id2<0 && dilmass>12 && lep2.Pt(>20 && nbtagscsvm ==0 && ele27wp80","PE")
```



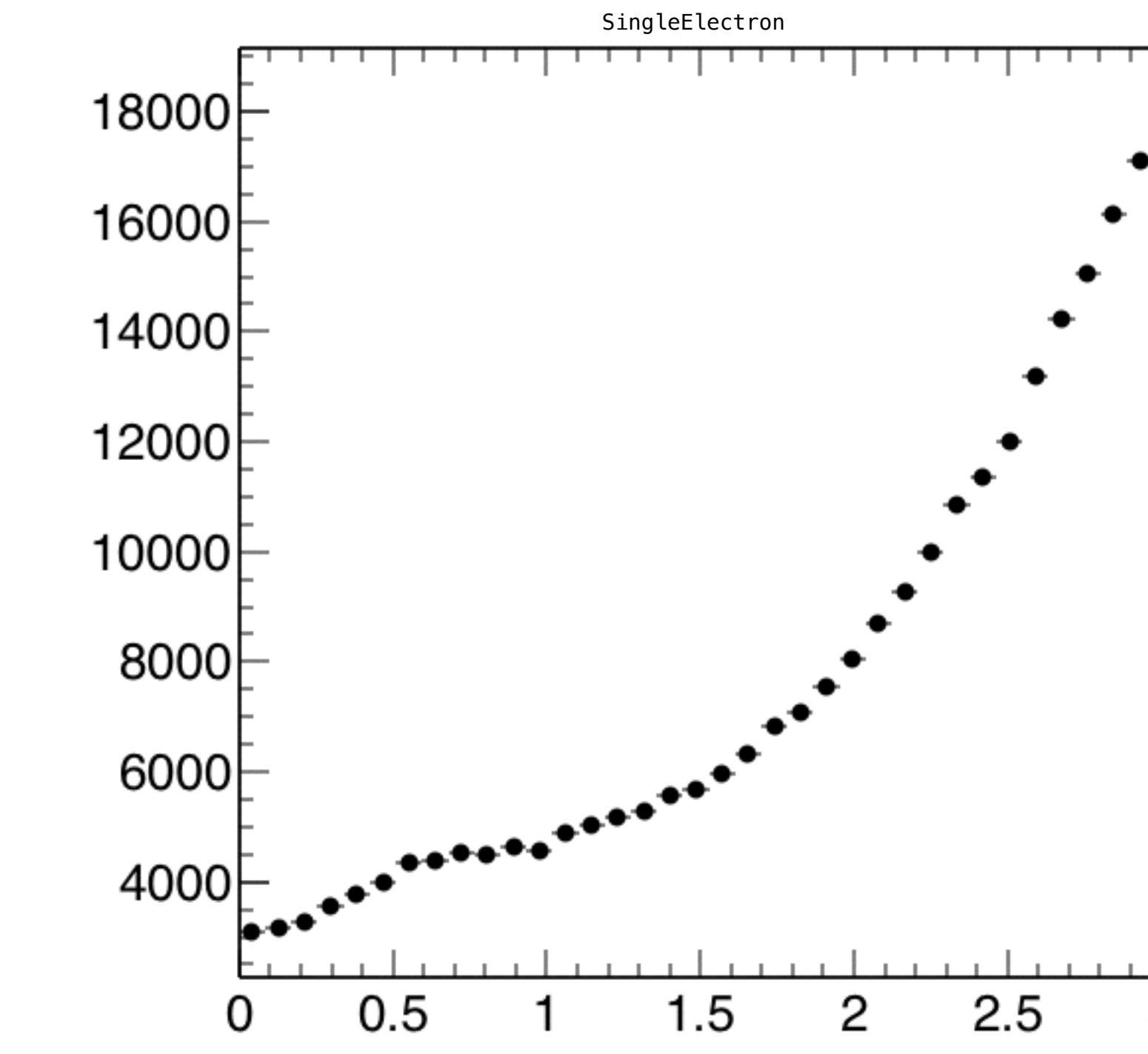
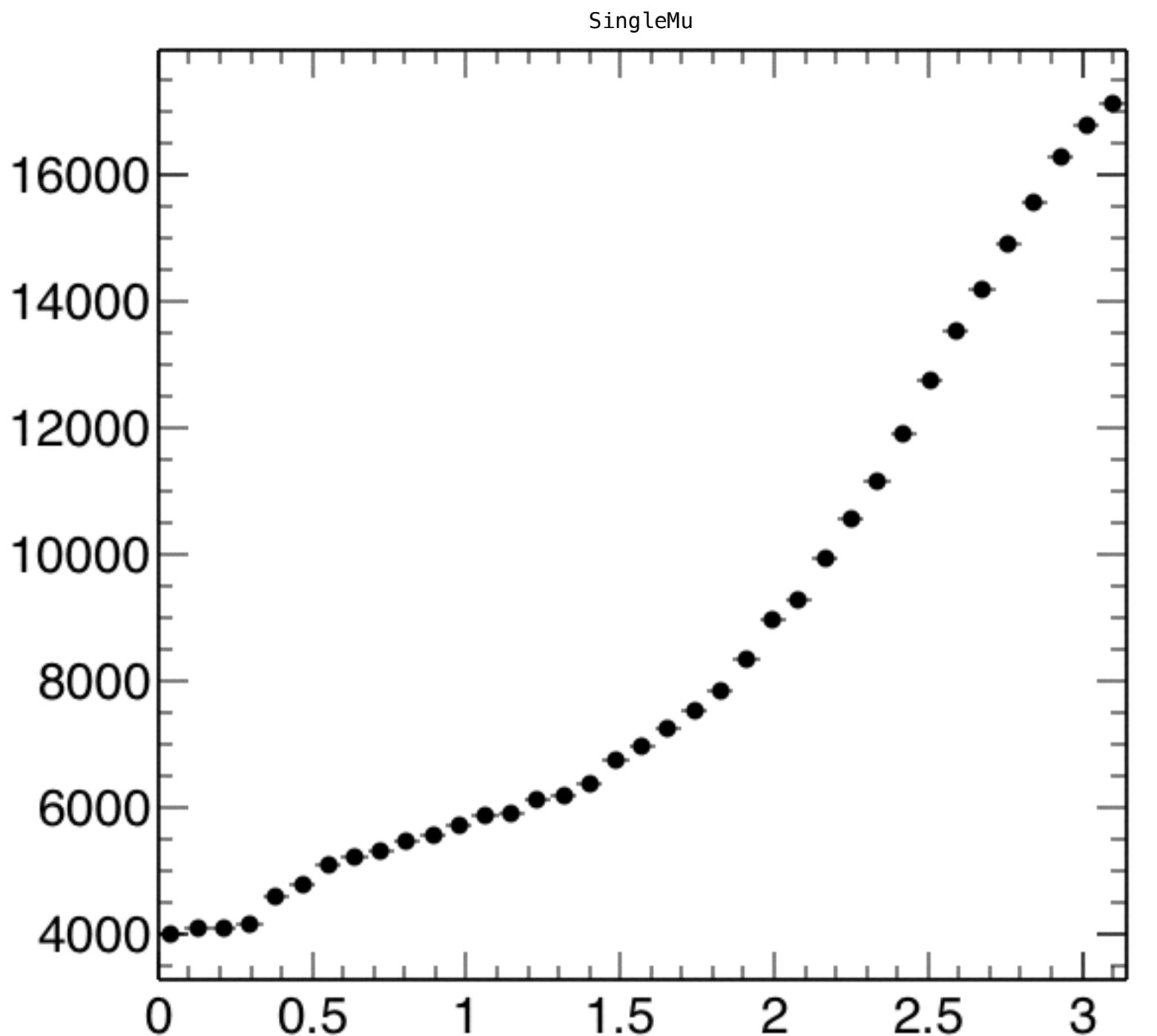
# Single muon dataset and trigger, 0 btags

```
t.Draw("abs(2*asin(sin(id1*lep1.Phi()/2./abs(id1)+id2*lep2.Phi()/2./abs(id2))))>>h2(37,0,3.14159265359)", "ngoodlep==2 && id1*id2<0 && dilmass>12 && lep2.Pt(>20 && nbtagscsvm ==0 && isomu24","PE")
```



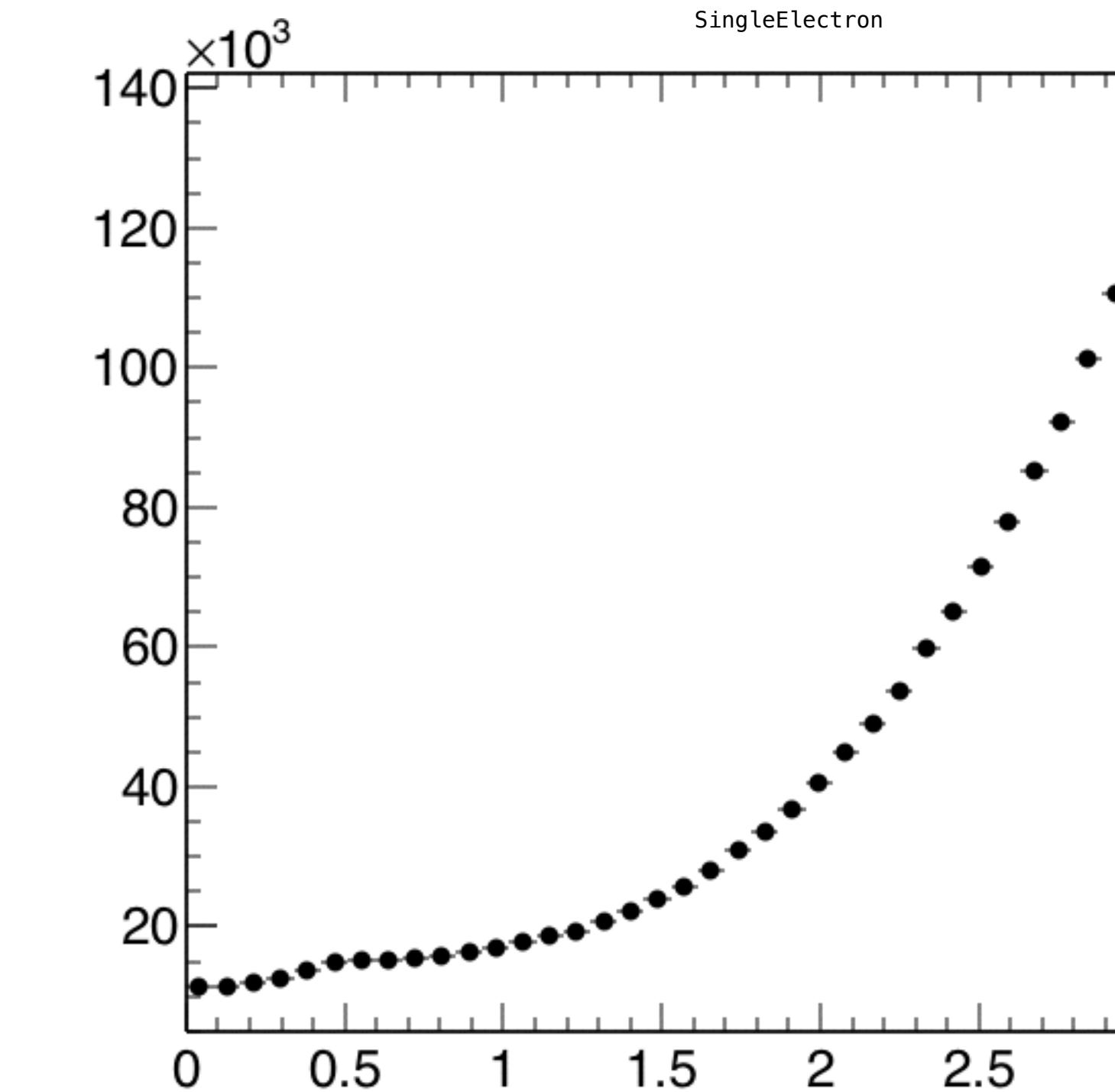
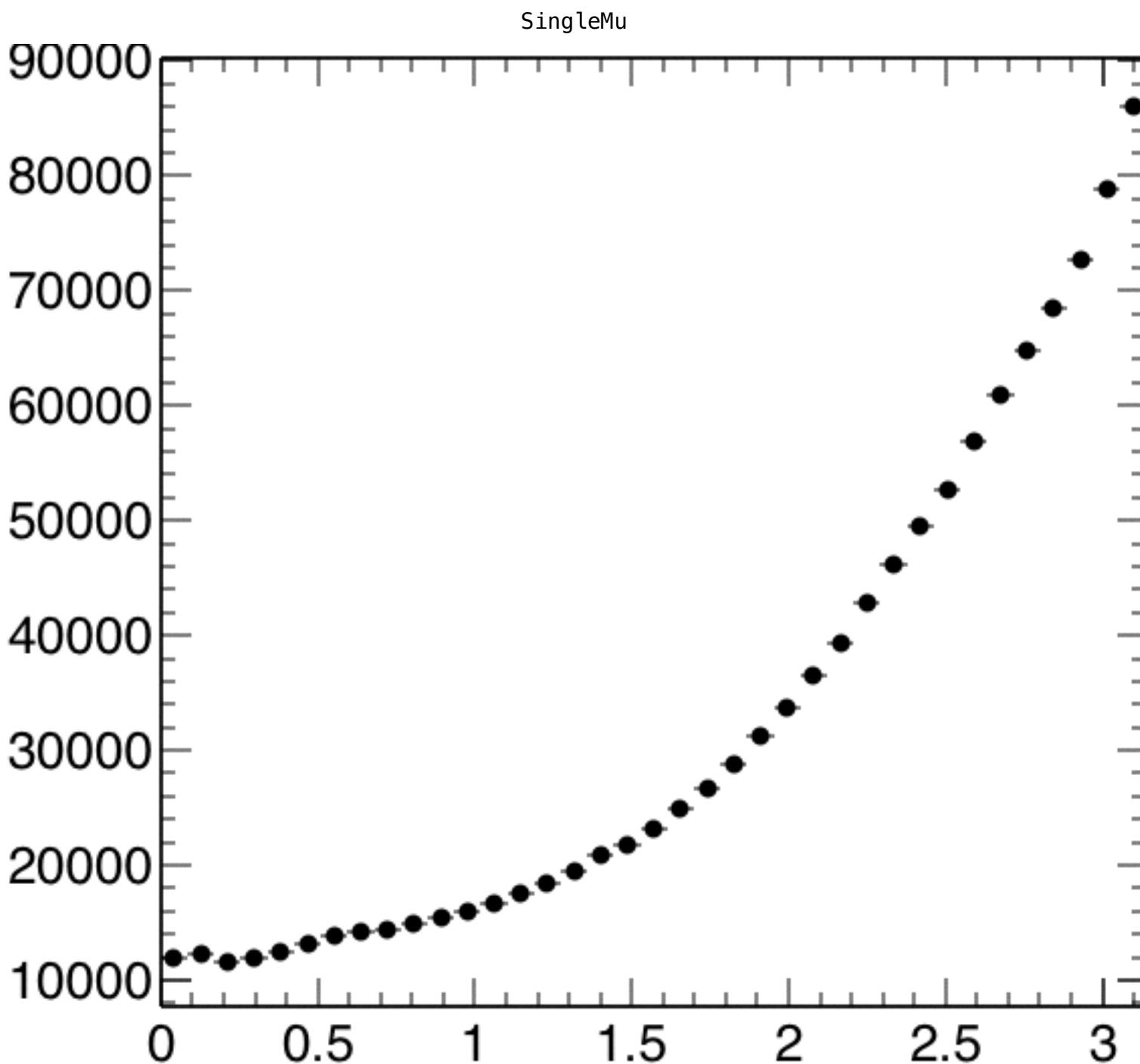
# Single lepton dataset and isotrk, >0 btags

```
t.Draw("abs(2*asin(sin(lep1.Phi())/2.-pfcand0S10.Phi()/2.))>>h2(37,0,3.14159265359)", "ngoodlep==1 && pfcand0S10.Pt()>20 && nbtagscsvm !=0","PE")
```



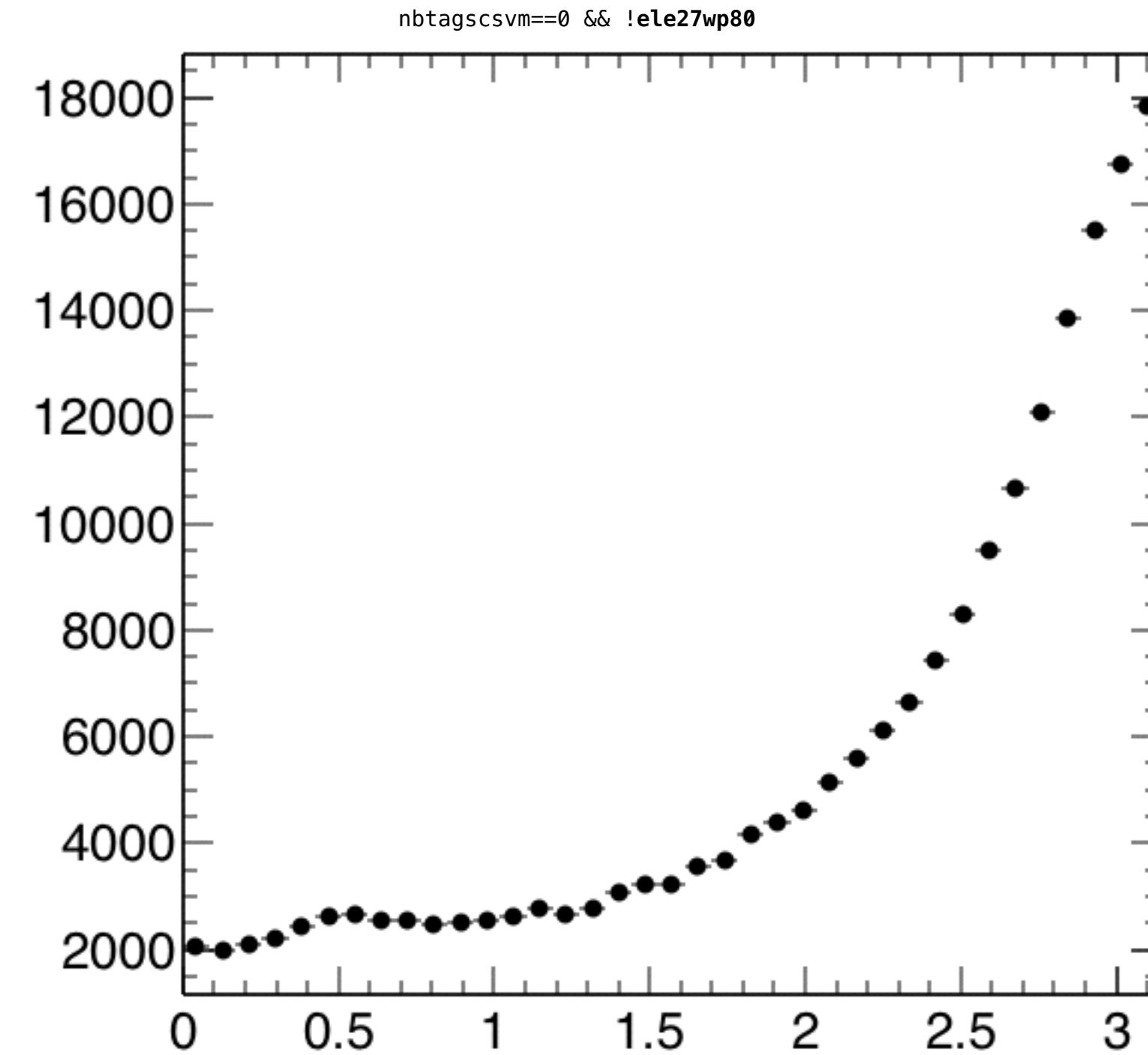
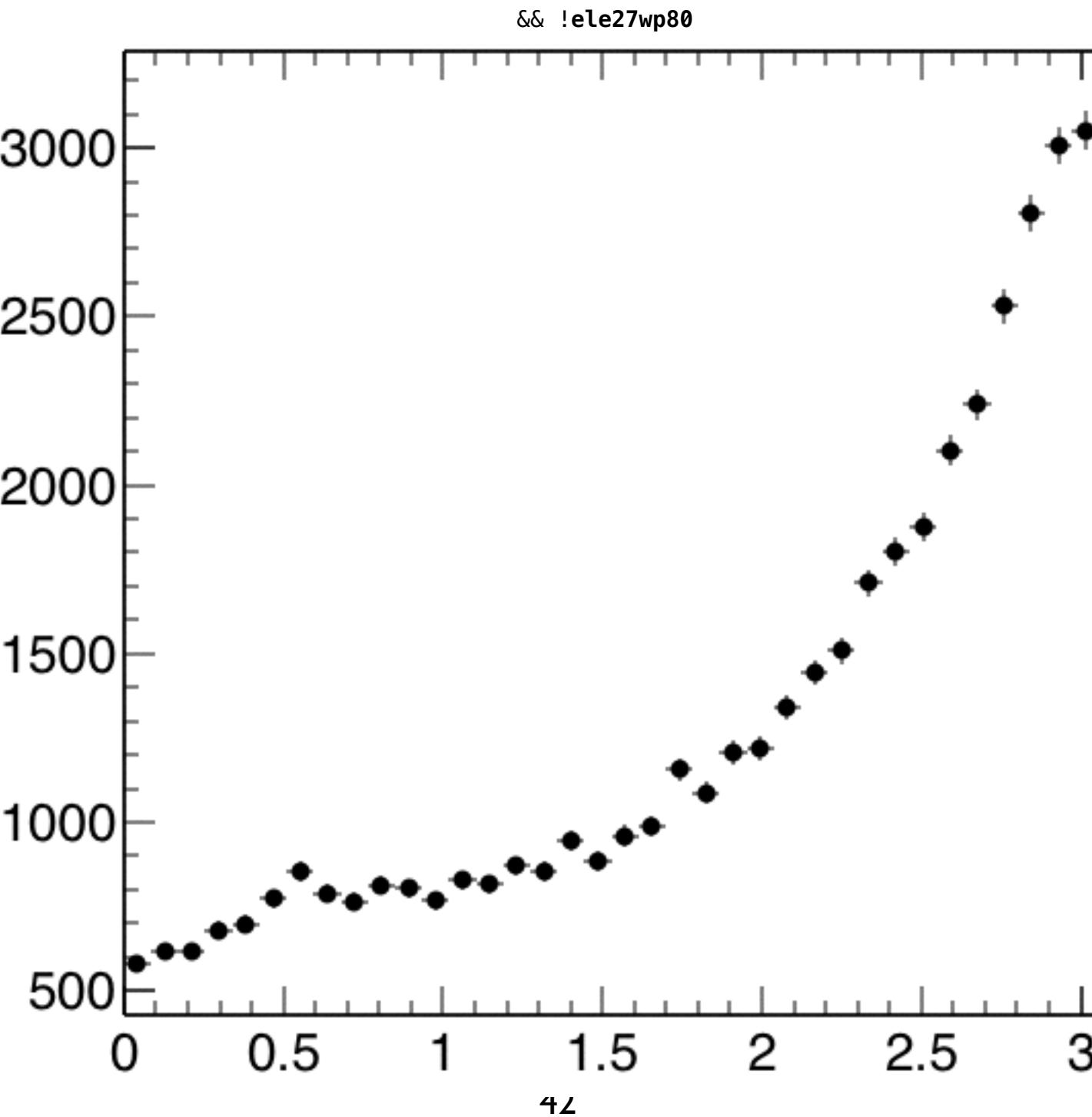
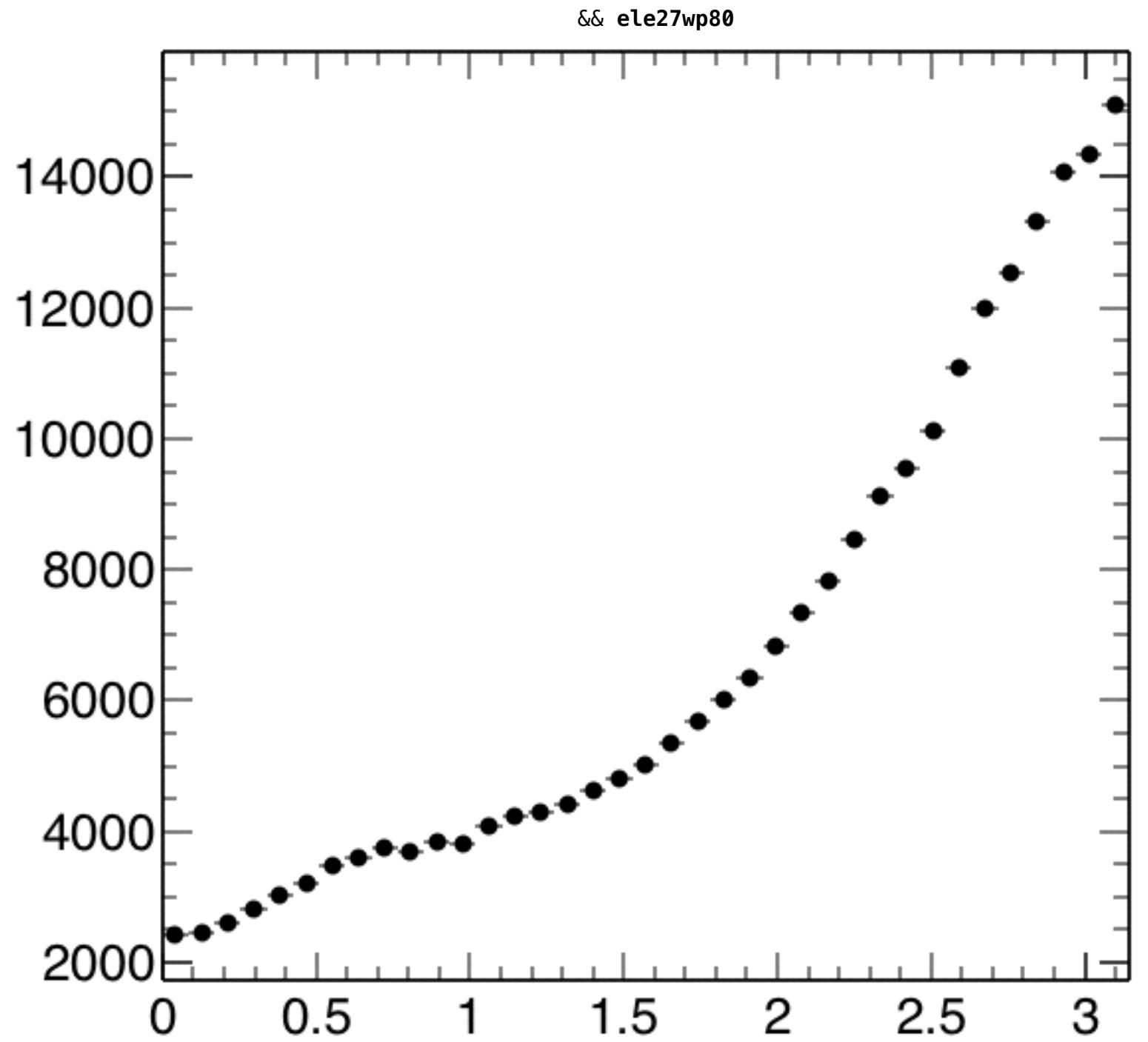
# Single lepton dataset and isotrk, 0 btags

```
t.Draw("abs(2*asin(sin(lep1.Phi())/2.-pfcand0S10.Phi()/2.))>>h2(37,0,3.14159265359)", "n good lep == 1 && pfcand0S10.Pt() > 20 && nbtagscsvm == 0", "PE")
```



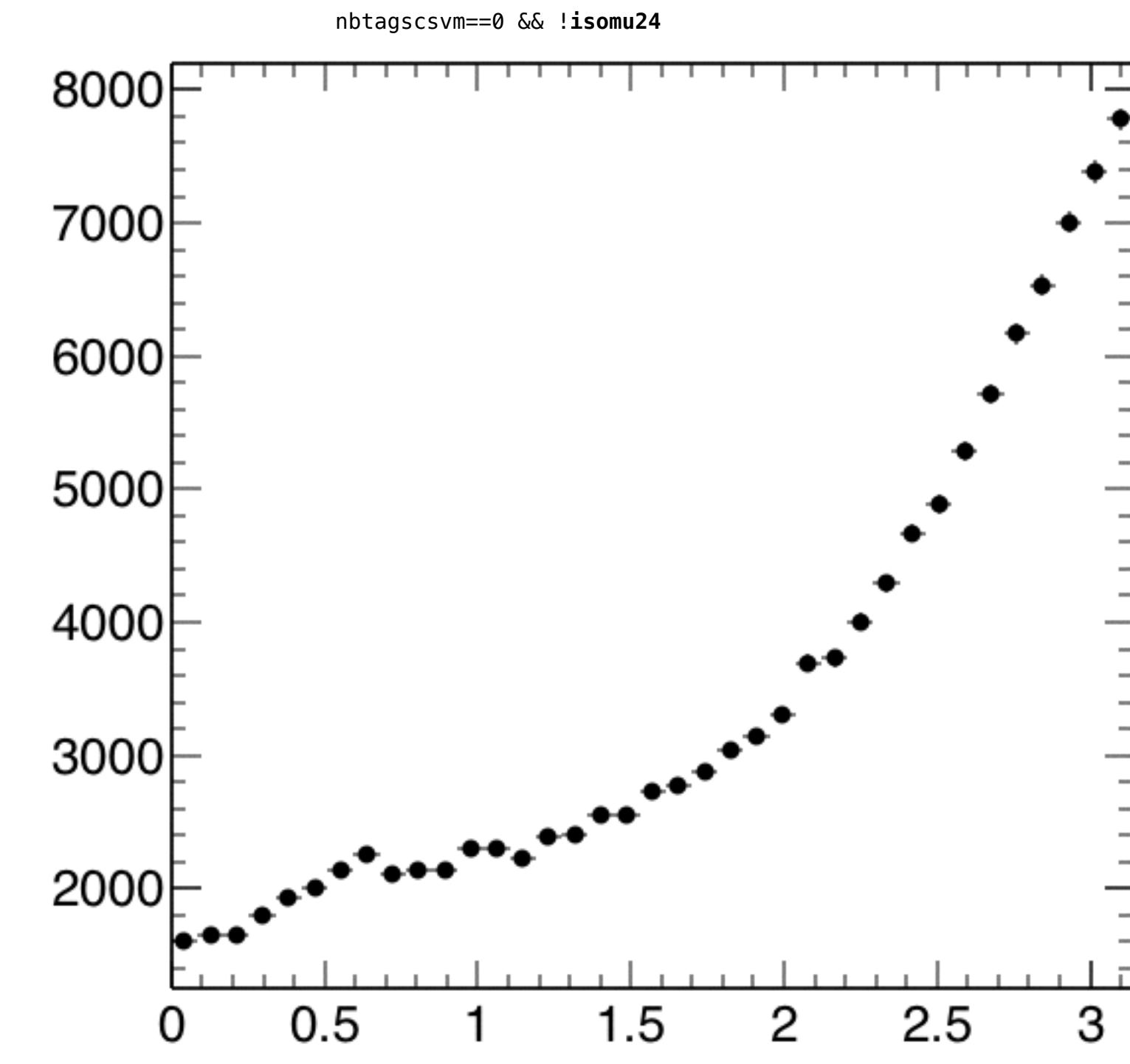
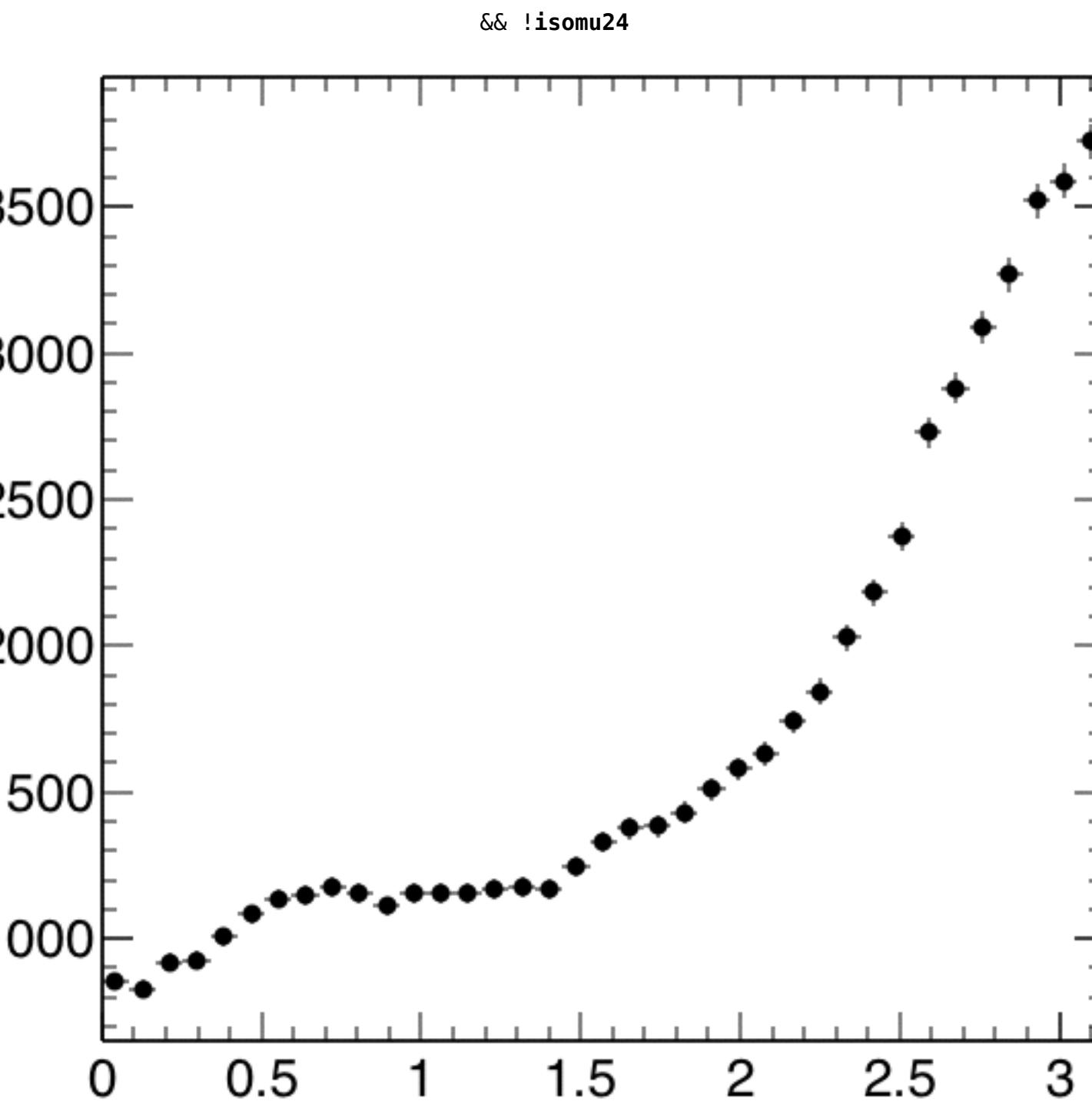
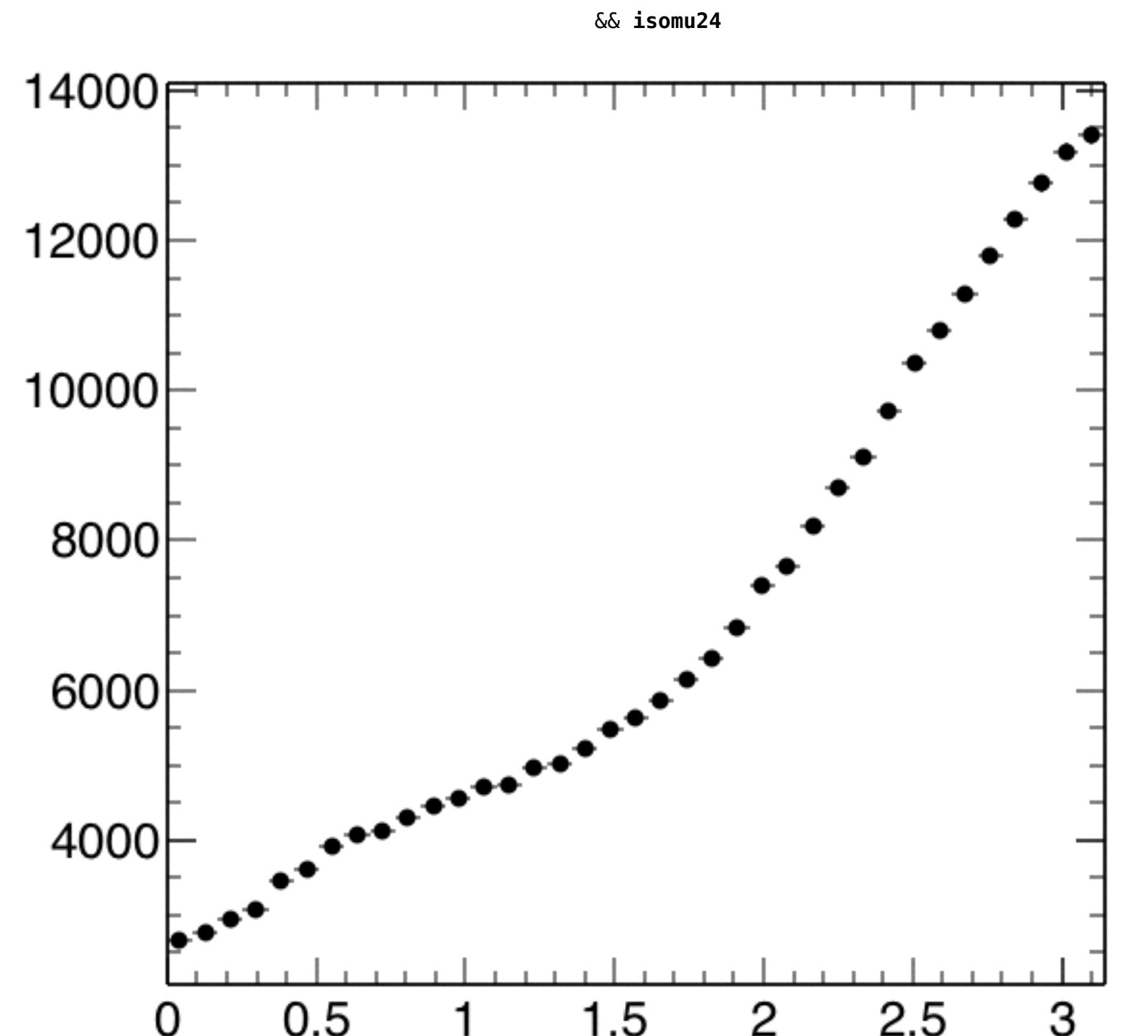
# Electron + isotrk

```
t.Draw("abs(2*asin(sin(lep1.Phi())/2.-pfcand0S10.Phi()/2.))>>h2(37,0,3.14159265359)", "ngoodlep==1 && sqrt( (lep1.E() + pfcand0S10.E())^2 - (lep1.Px() + pfcand0S10.Px())^2 - (lep1.Py() + pfcand0S10.Py())^2 - (lep1.Pz() + pfcand0S10.Pz())^2 ) >12 && pfcand0S10.Pt(>20 && nbtagscsvm !=0", "PE")
```



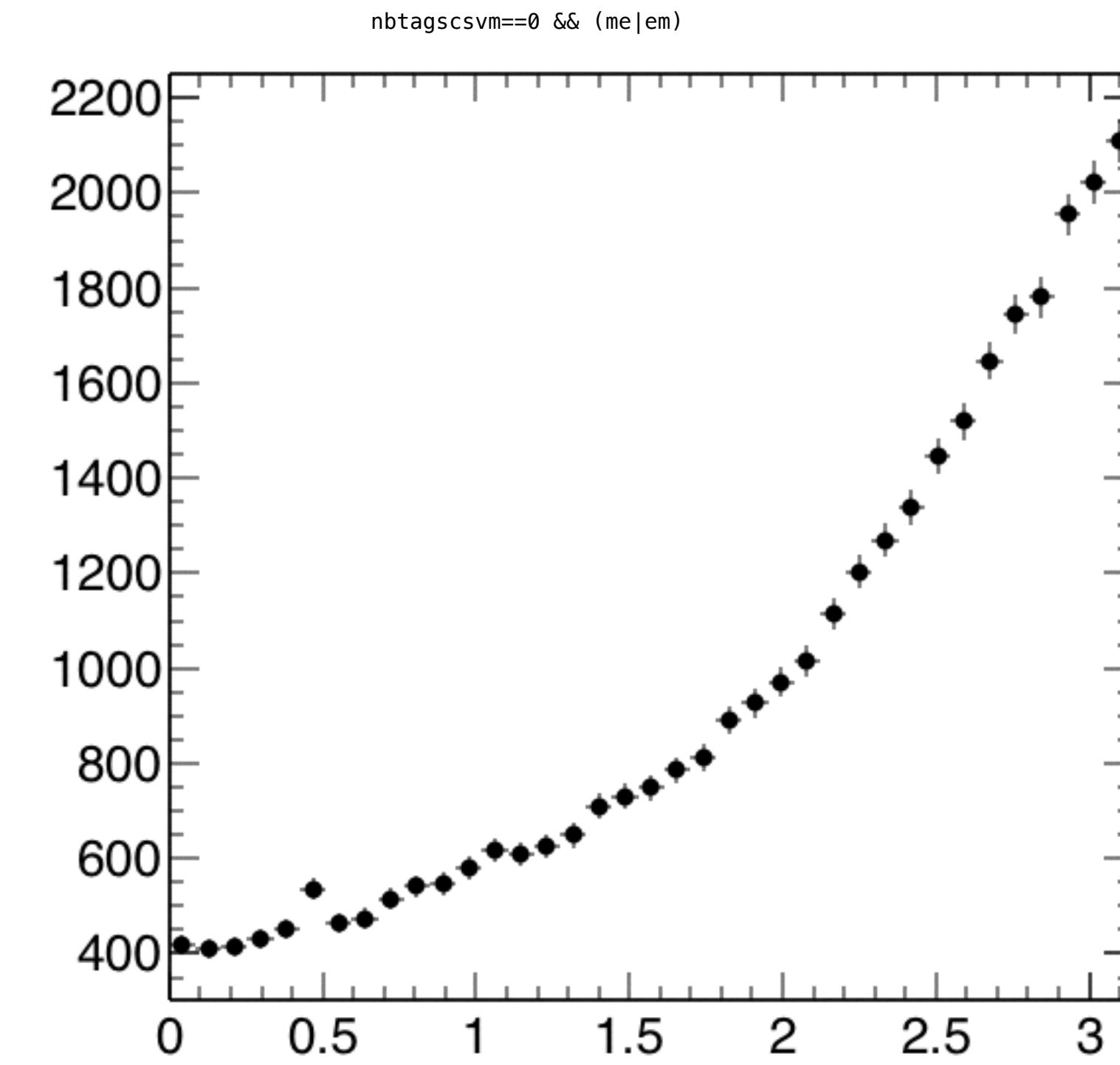
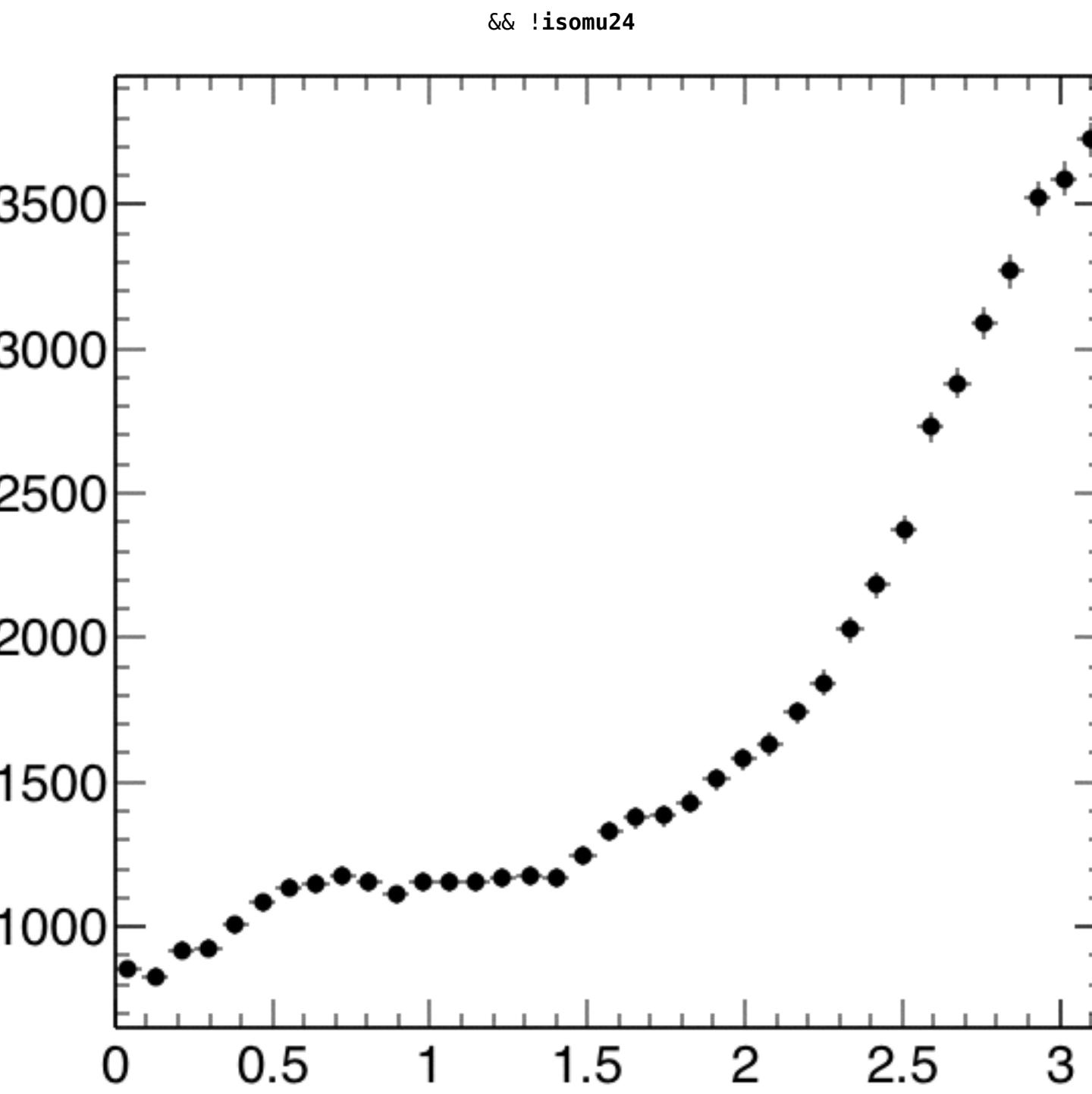
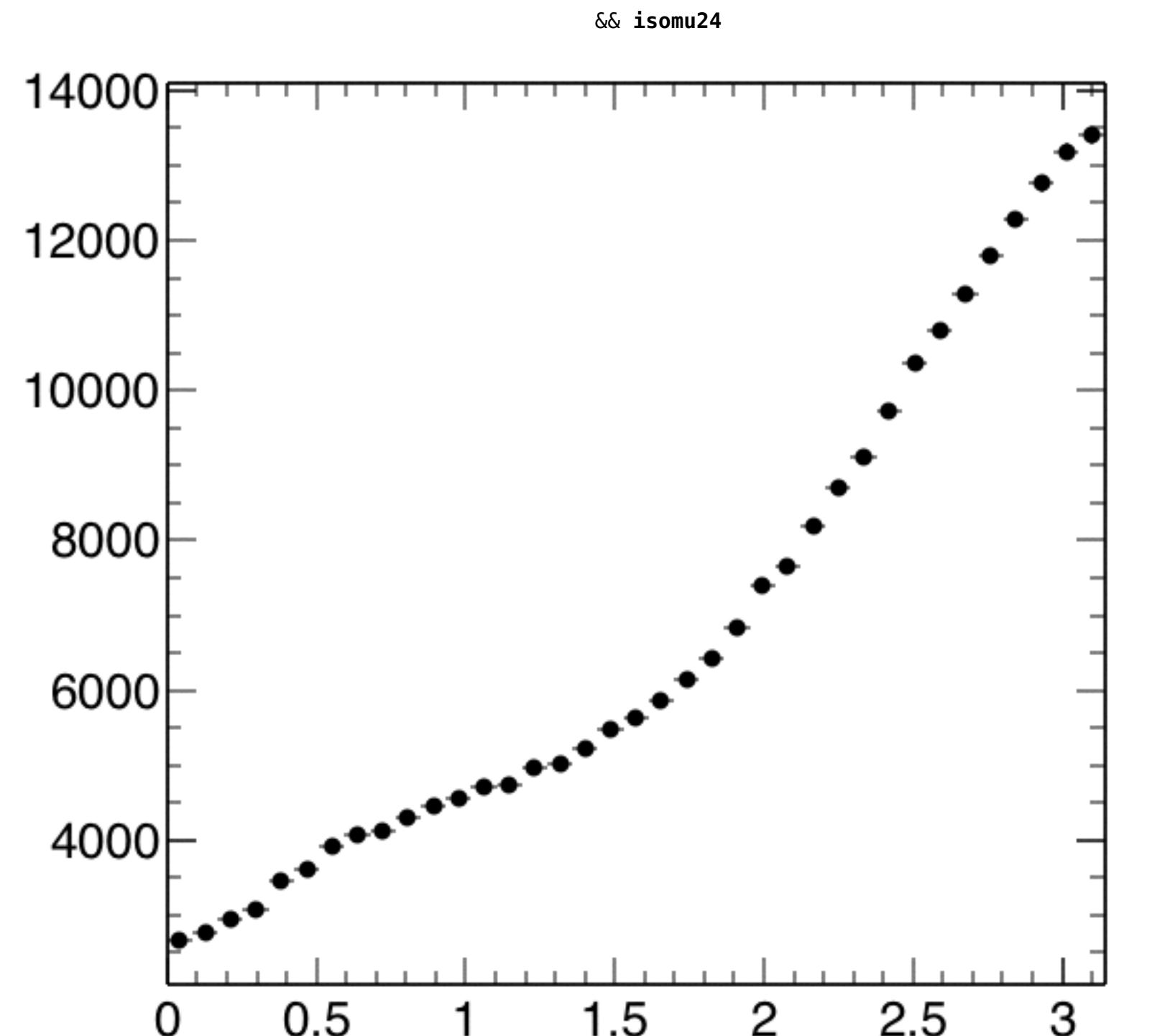
# muon + isotrk

```
t.Draw("abs(2*asin(sin(lep1.Phi())/2.-pfcand0S10.Phi()/2.))>>h2(37,0,3.14159265359)", "ngoodlep==1 && sqrt( (lep1.E() + pfcand0S10.E())^2 - (lep1.Px() + pfcand0S10.Px())^2 - (lep1.Py() + pfcand0S10.Py())^2 - (lep1.Pz() + pfcand0S10.Pz())^2 ) >12 && pfcand0S10.Pt()>20 && nbtagscsvm !=0", "PE")
```



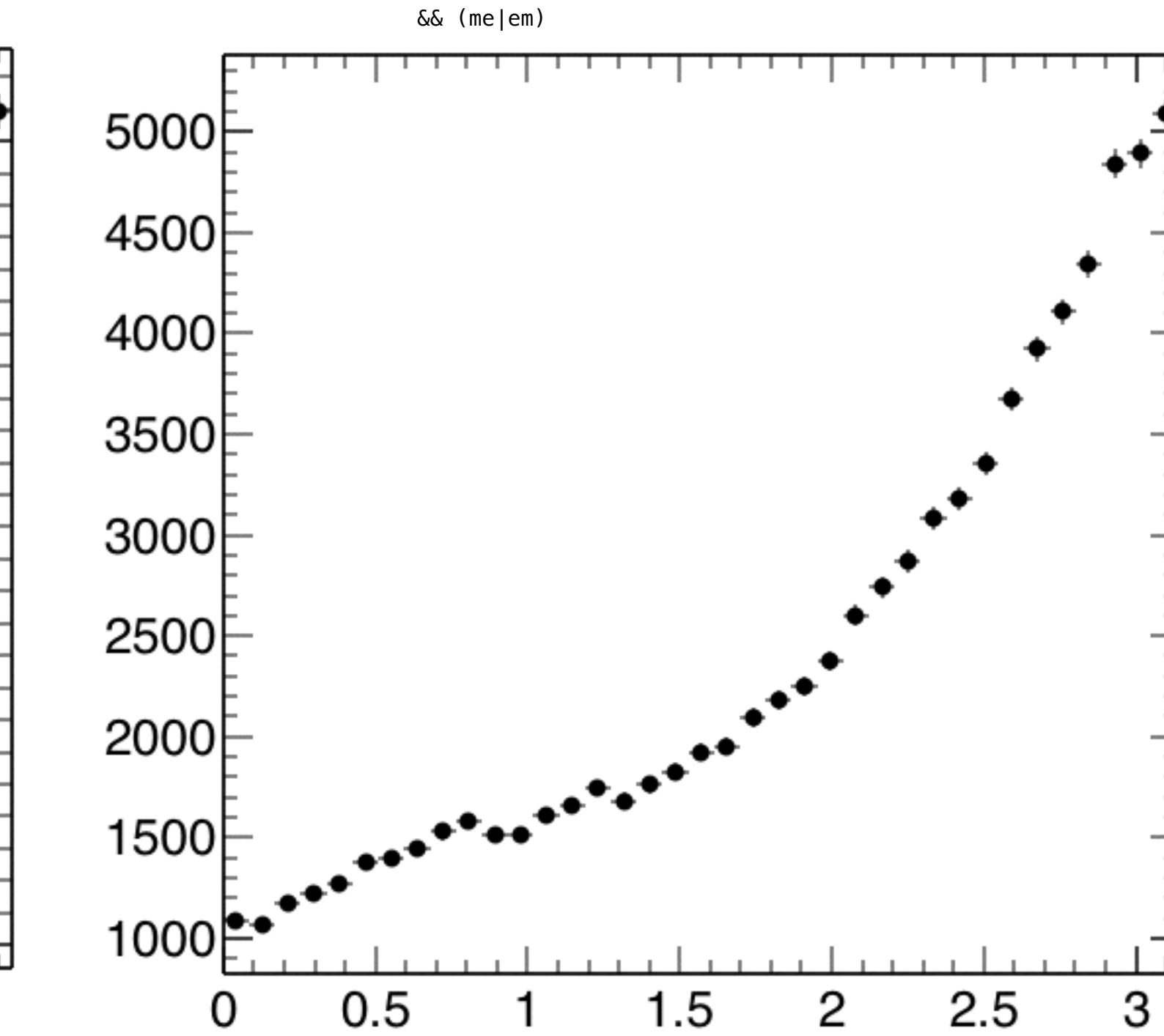
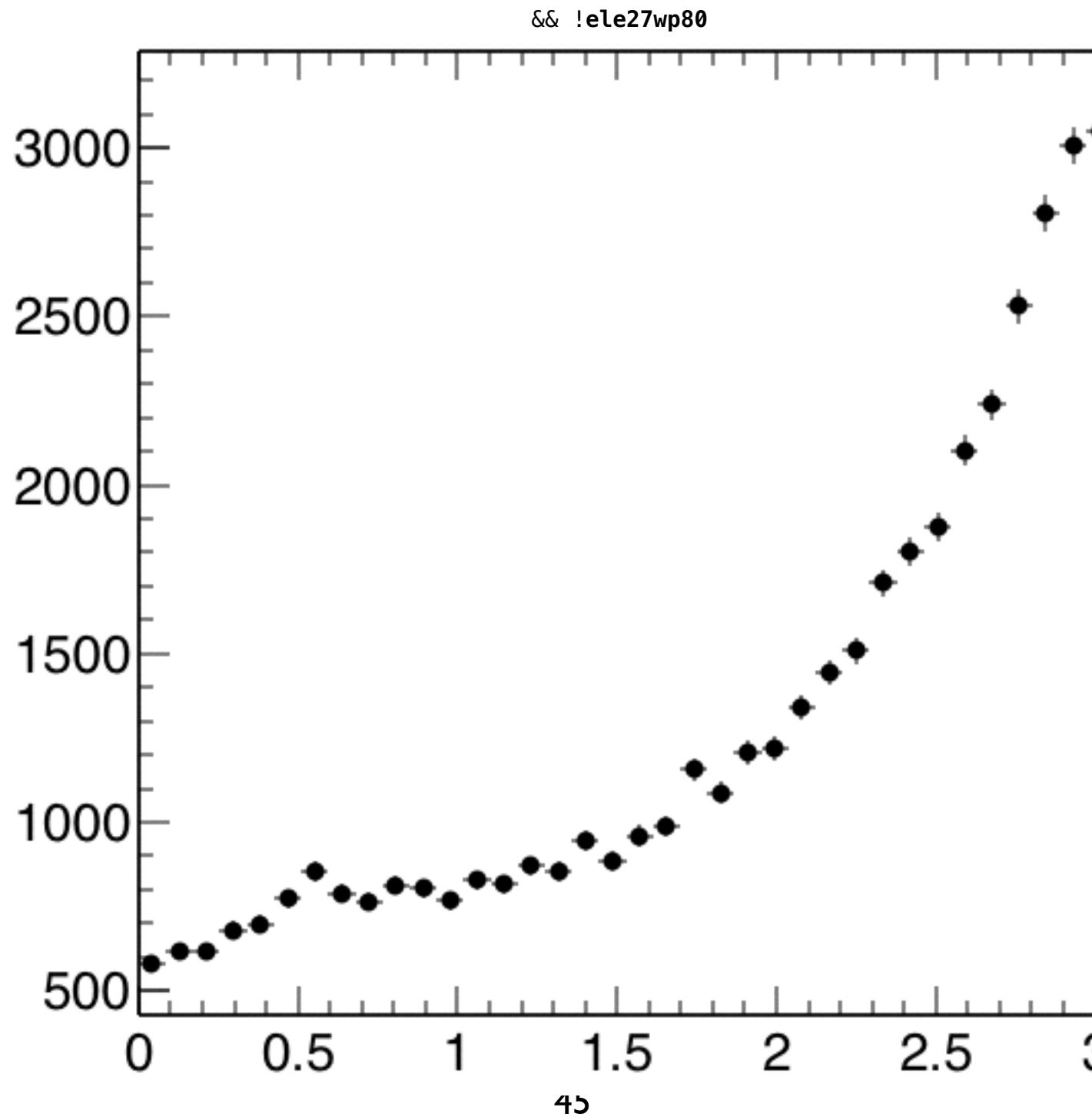
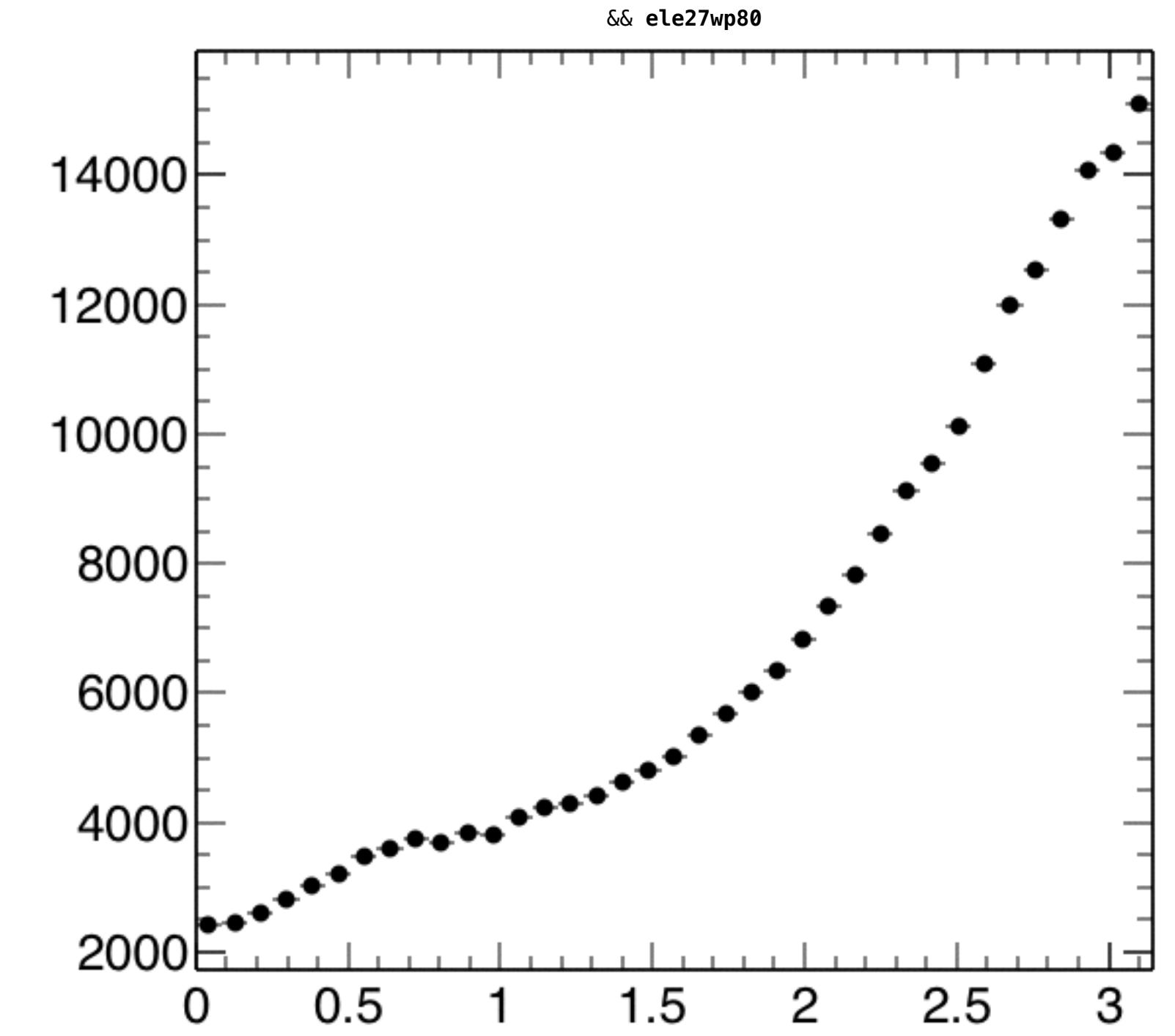
# muon + isotrk

```
t.Draw("abs(2*asin(sin(lep1.Phi())/2.-pfcand0S10.Phi()/2.))>>h2(37,0,3.14159265359)", "ngoodlep==1 && sqrt( (lep1.E() + pfcand0S10.E())^2 - (lep1.Px() + pfcand0S10.Px())^2 - (lep1.Py() + pfcand0S10.Py())^2 - (lep1.Pz() + pfcand0S10.Pz())^2 ) >12 && pfcand0S10.Pt()>20 && nbtagscsvm !=0", "PE")
```



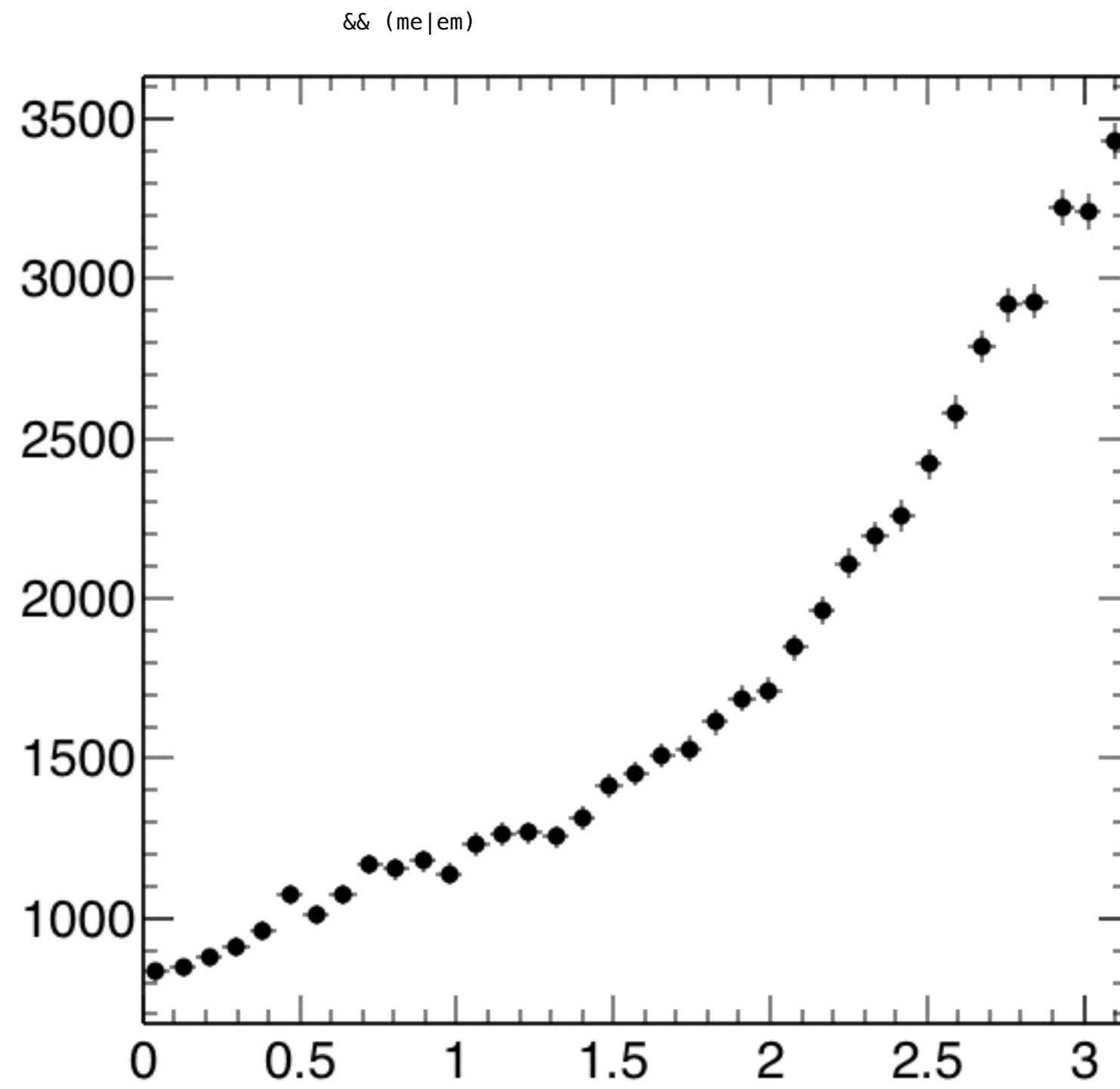
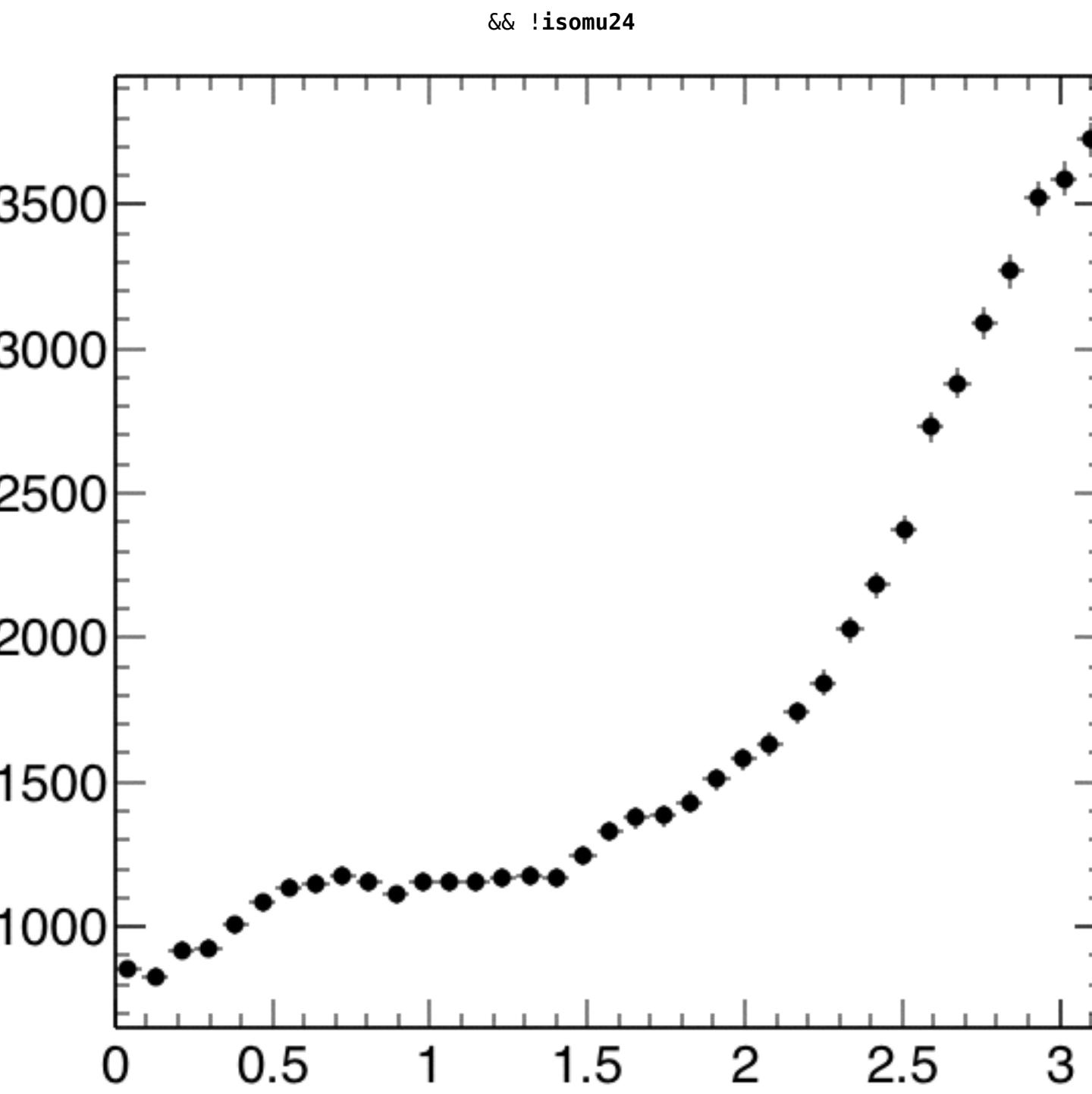
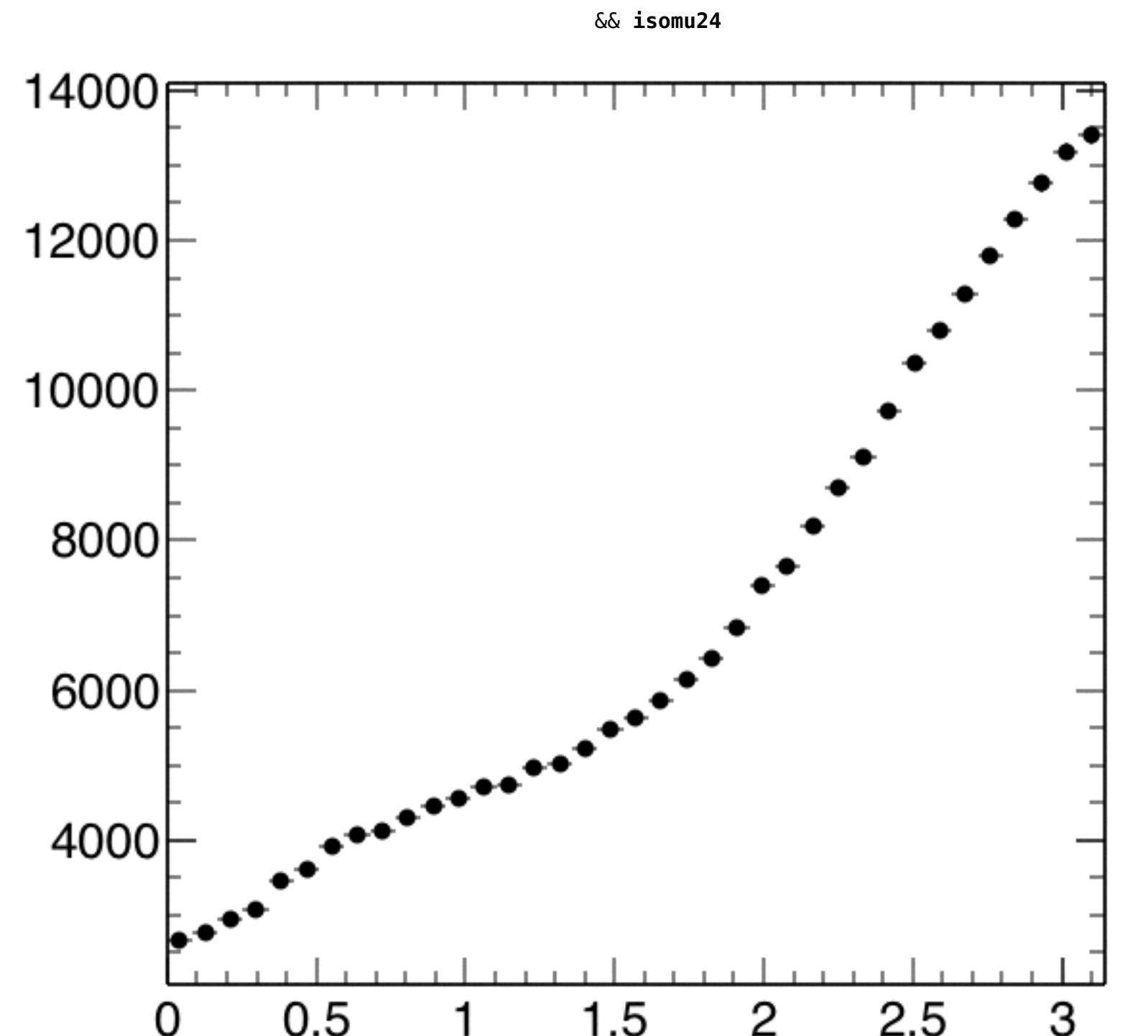
# Electron + isotrk

```
t.Draw("abs(2*asin(sin(lep1.Phi())/2.-pfcand0S10.Phi()/2.))>>h2(37,0,3.14159265359)", "ngoodlep==1 && sqrt( (lep1.E() + pfcand0S10.E())^2 - (lep1.Px() + pfcand0S10.Px())^2 - (lep1.Py() + pfcand0S10.Py())^2 - (lep1.Pz() + pfcand0S10.Pz())^2 ) >12 && pfcand0S10.Pt(>20 && nbtagscsvm !=0", "PE")
```



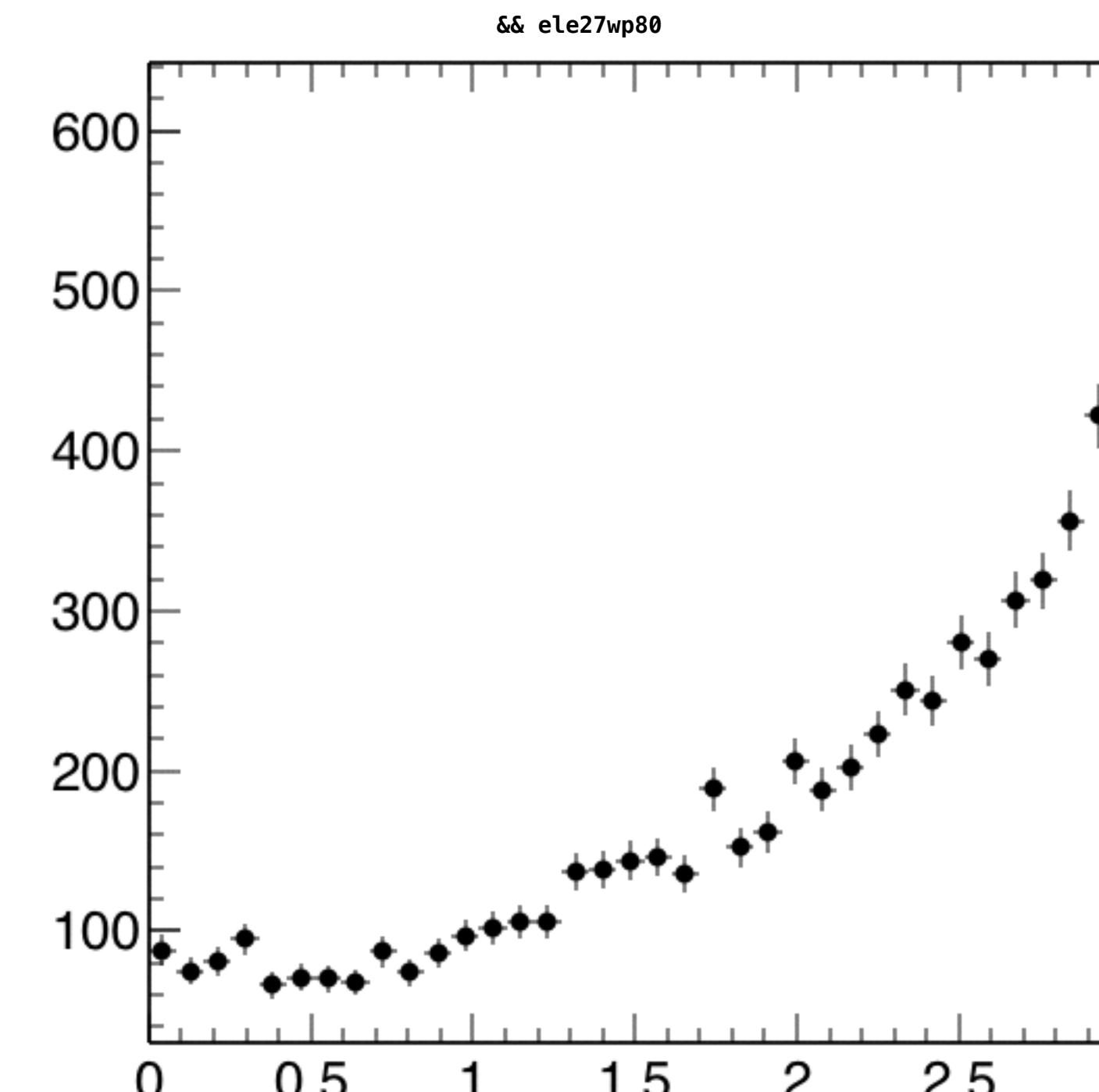
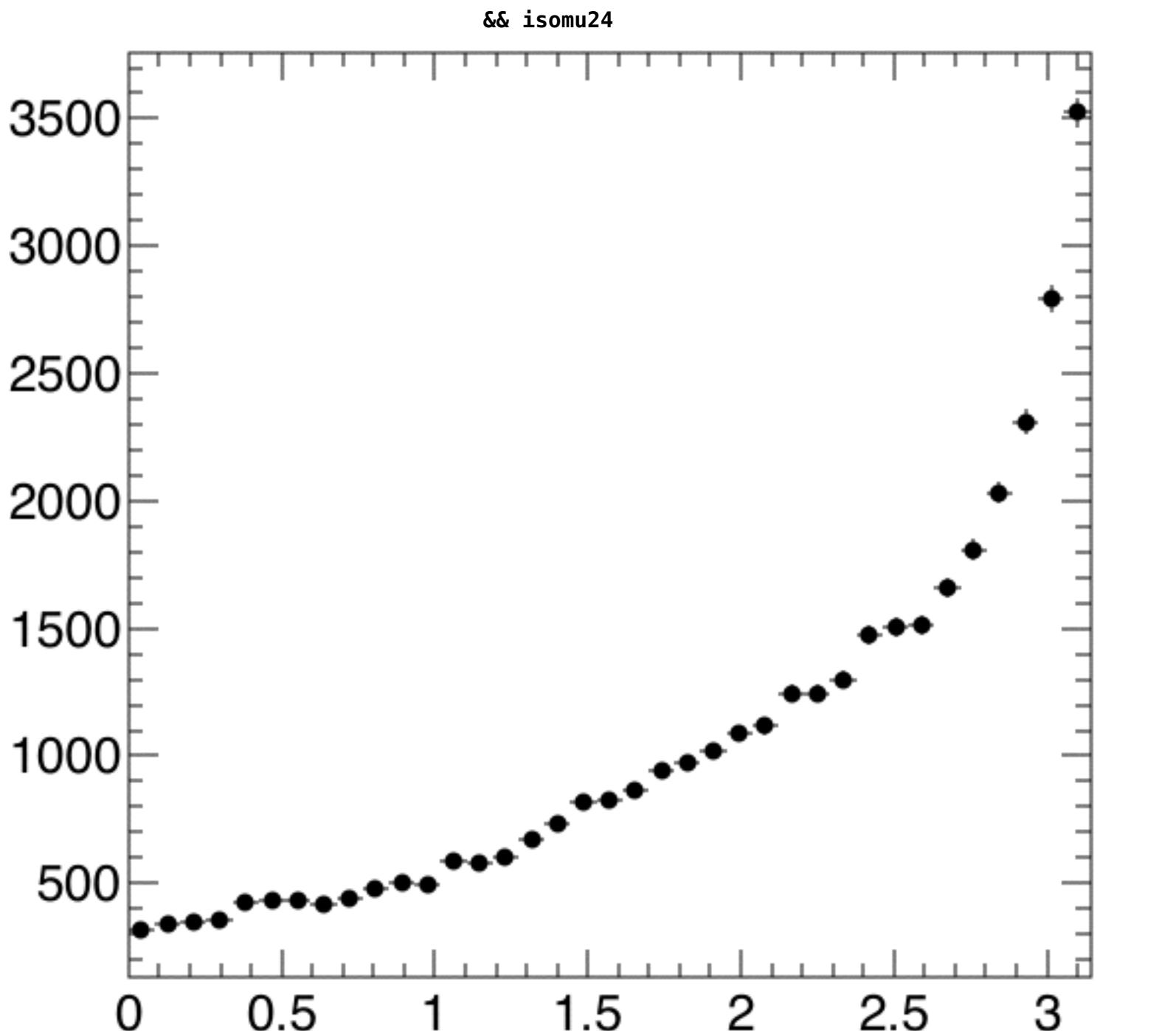
# muon + isotrk

```
t.Draw("abs(2*asin(sin(lep1.Phi())/2.-pfcand0S10.Phi()/2.))>>h2(37,0,3.14159265359)", "ngoodlep==1 && sqrt( (lep1.E() + pfcand0S10.E())^2 - (lep1.Px() + pfcand0S10.Px())^2 - (lep1.Py() + pfcand0S10.Py())^2 - (lep1.Pz() + pfcand0S10.Pz())^2 ) >12 && pfcand0S10.Pt()>20 && nbtagscsvm !=0", "PE")
```



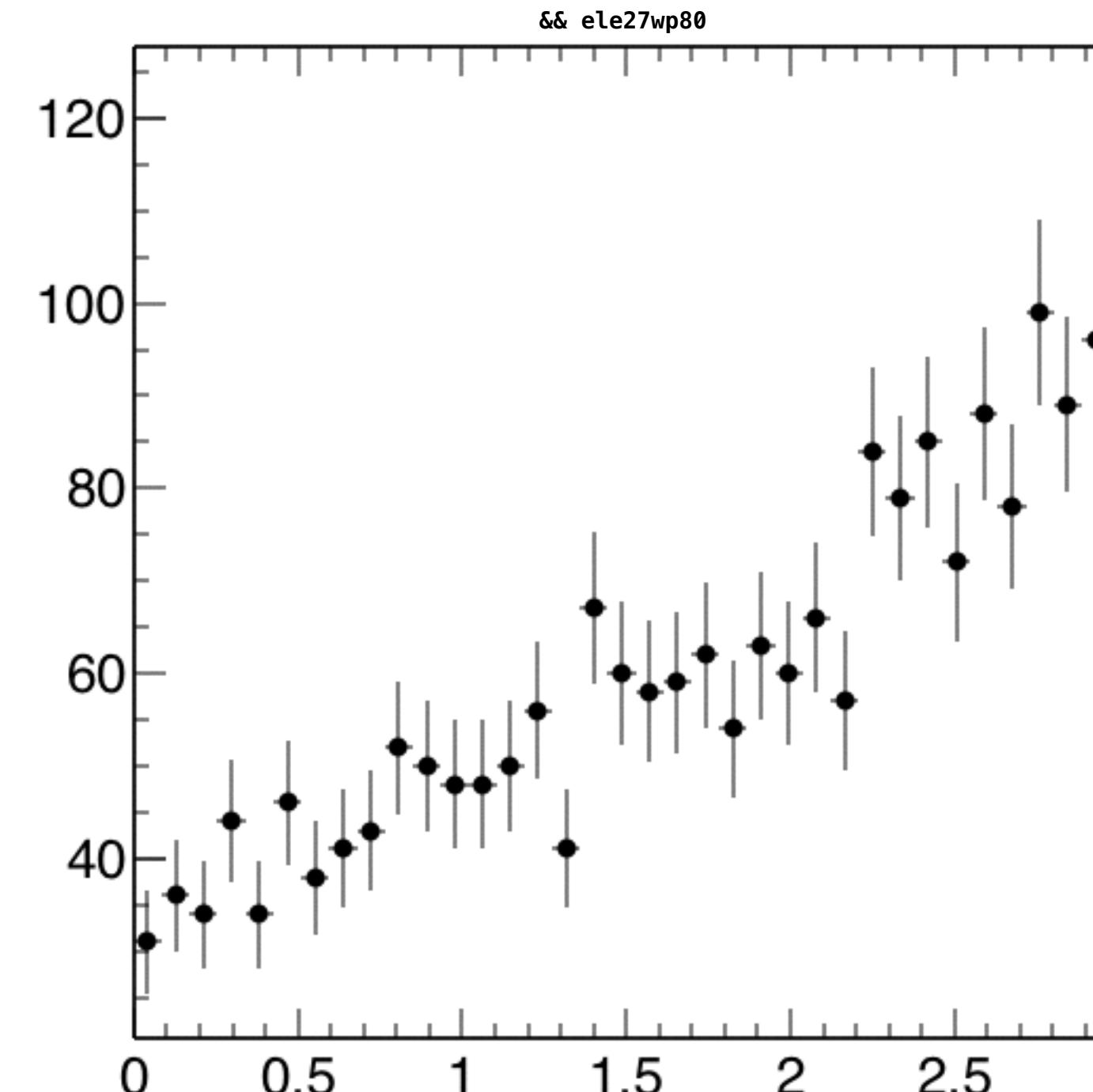
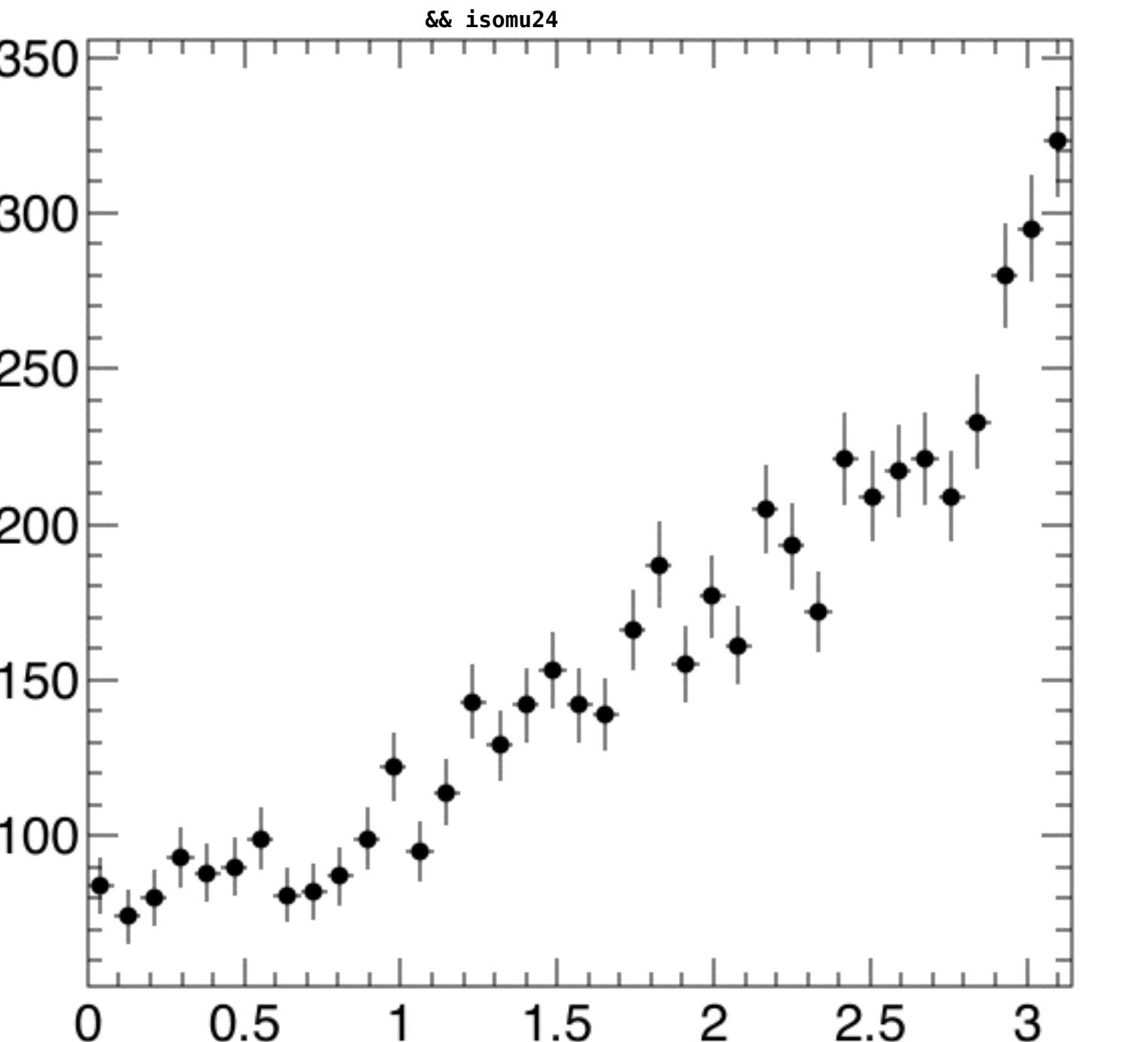
# Single lepton trigger, 2 good leptons, but not dilepton trigger, no btag

```
t.Draw("acos(cos(lep1.Phi())-lep2.Phi()))>>h2(37,0,3.14159265359)", "ngoodlep==2 && id1*id2<0 && dilmass>12 && lep2.Pt()>20 && !(me|em|mm|ee)","PE")
```



# Single lepton trigger, 2 good leptons, but not dilepton trigger

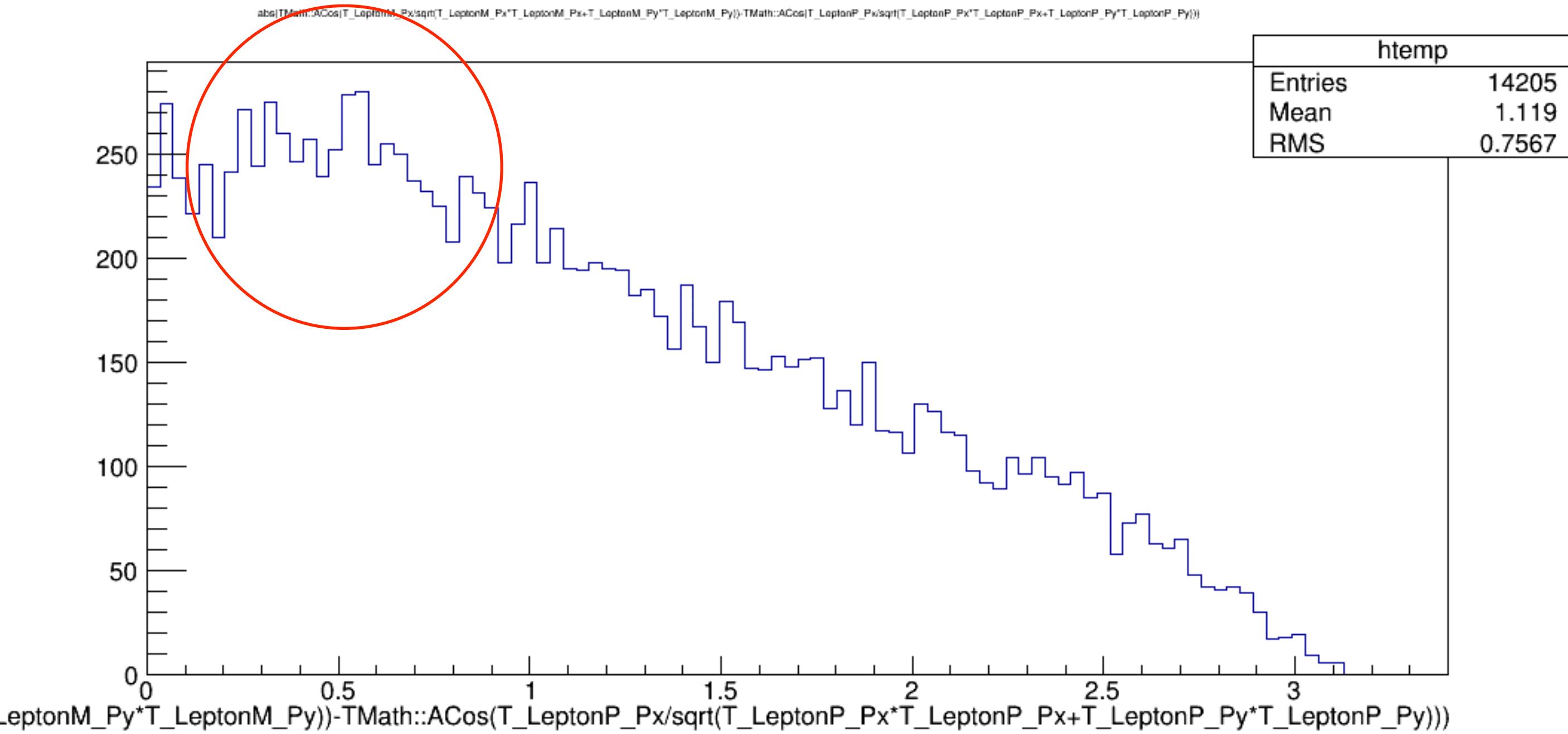
```
t.Draw("acos(cos(lep1.Phi())-lep2.Phi()))>>h2(37,0,3.14159265359)", "ngoodlep==2 && id1*id2<0 && dilmass>12 && lep2.Pt()>20 && !(me|em|mm|ee) && nbtagscsvm !=0","PE")
```



# DiMuon plot from Mohsen (working on dilepton W Helicity measurement in properties group):

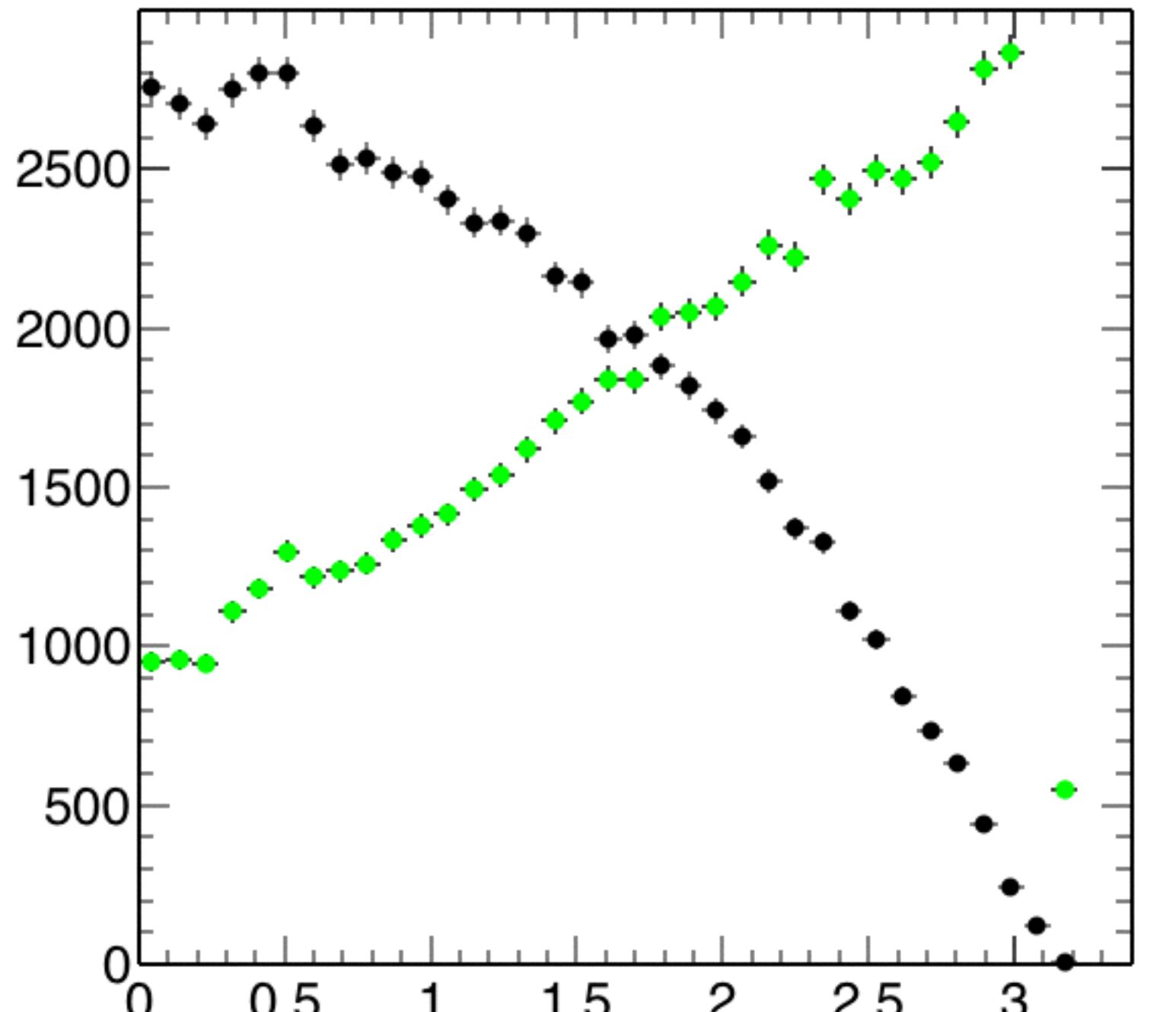
```
DiMuonEff->Draw("abs(TMath::ACos(T_LeptonM_Px/sqrt(T_LeptonM_Px*T_LeptonM_Py*T_LeptonM_Py))-TMath::ACos(T_LeptonP_Px/sqrt(T_LeptonP_Px*T_LeptonP_Py*T_LeptonP_Py)))")
```

- This shows  $\Delta|\phi|$  instead of  $\Delta\phi$
- But the bump is in the same place (next slide)
- Looks like they might see it too (will ask for more plots)

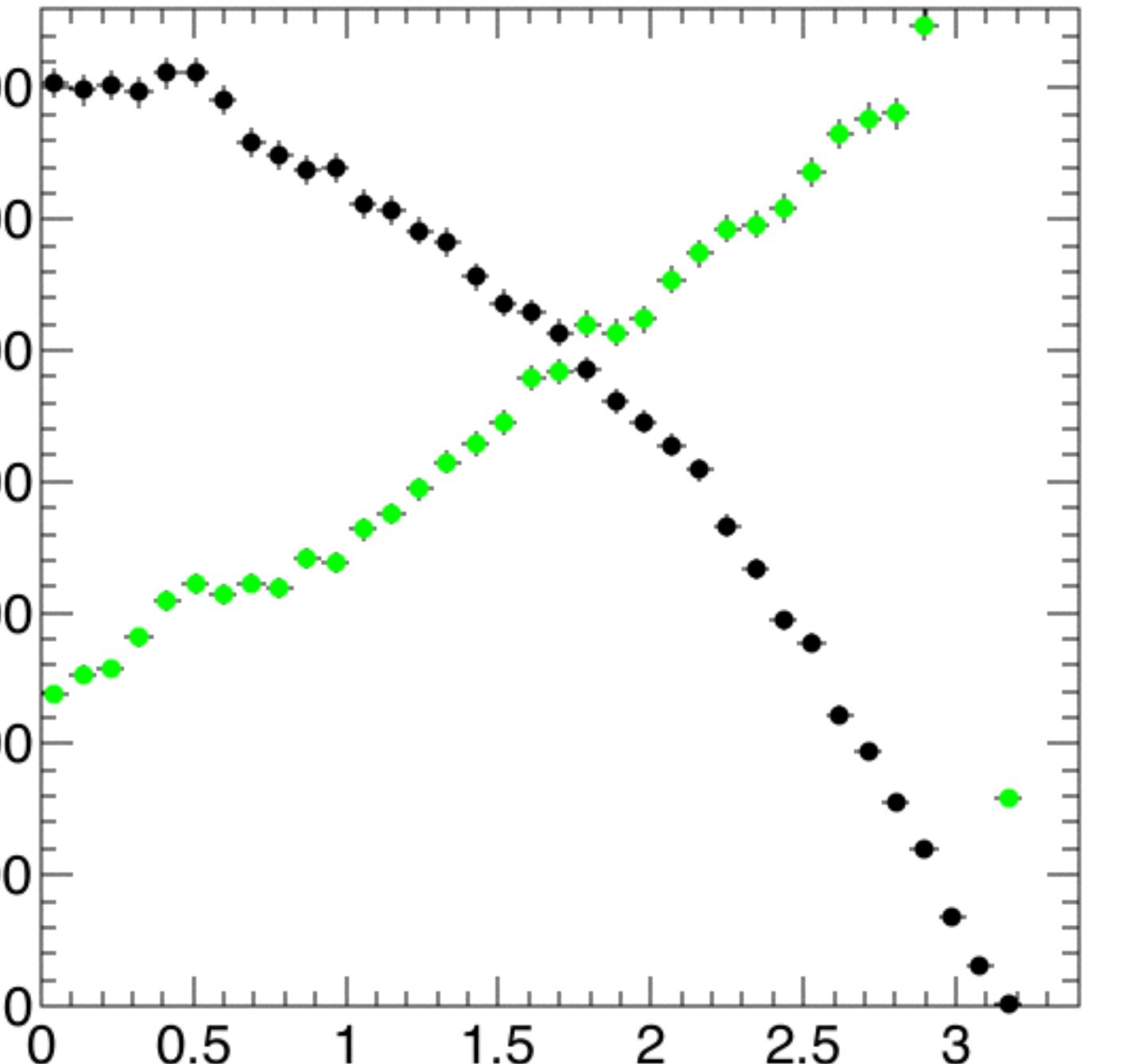


# $\Delta\phi$ is defined differently, but bump in same place

```
t.Draw("abs(TMath::ACos(lep1.Px())/sqrt(lep1.Px()*lep1.Px())  
+lep1.Py()*lep1.Py())-TMath::ACos(lep2.Px())/sqrt(lep2.Px()*lep2.Px())  
+lep2.Py()*lep2.Py()))>>h44", "ngoodlep==2 && id1*id2<0 && dilmass>12 &&  
lep2.Pt(>20 && nbtagscsvm !=0 && ele27wp80","PE")
```



```
t.Draw("abs(TMath::ACos(lep1.Px())/sqrt(lep1.Px()*lep1.Px())  
+lep1.Py()*lep1.Py())-TMath::ACos(lep2.Px())/sqrt(lep2.Px()*lep2.Px())  
+lep2.Py()*lep2.Py()))>>h44", "ngoodlep==2 && id1*id2<0 && dilmass>12 &&  
lep2.Pt(>20 && nbtagscsvm !=0 && isomu24","PE")
```



```
t.Draw("abs(TMath::ACos(lep1.Px())/sqrt(lep1.Px()*lep1.Px())  
+lep1.Py()*lep1.Py())-TMath::ACos(lep2.Px())/sqrt(lep2.Px()*lep2.Px())  
+lep2.Py()*lep2.Py()))>>h44(37,0,3.14159265359)", "ngoodlep==2 && id1*id2<0 &&  
dilmass>12 && lep2.Pt(>20 && nbtagscsvm !=0 && (me|em)","PE")
```

